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CONTENTS

No. 1, January, 1959

Edwin Morris Betts	1
Errors Associated with Process Adjustments — J. Edward Jackson, Richard A. Freund and William G. Howe	3
<i>Heliscus Tentaculus</i> , n. sp. An Aquatic Hyphomycete — Clyde J. Umphlett	27
Skin and Hair Follicle Development in Dairy Goats — Lubow A. Margolena	33
News and Notes	48

No. 2, April, 1959

Characters Differentiating Common Morning-Glories Occurring in Virginia — Robert J. Knight, III	63
A Study of the Chlorophyta of the James River Basin, Virginia — Bernard Woodson, Jr.	70
News and Notes	83
Program of the Thirty-Seventh Annual Meeting of the Virginia Academy of Science	101

No. 3, July, 1959

<i>Ginkgo Bibloba</i> L: Historical Summary and Bibliography — Alicelia Hoskins Franklin	131
A Preliminary Report on an Occurrence of <i>Camptostoma</i> <i>Anomalum</i> (Rafinesque) in the Yadkin River Drainage System — B. J. Abbott	177
The Tube Precipitation Technique as applied to the Study of Serological Relationships among Crayfishes — Rose Mary Johnson	181
The <i>In Vitro</i> Effects of X-Radiation on Human White Blood Cells — Samuel P. Maroney, Jr.	186
News and Notes	193

505.73

V 81

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V. 10

1959

No. 4, September, 1959

Proceedings for the Year 1958-59

Minutes of the Thirty-Seventh Annual Meeting,

May 6, 7, 8, 9, 1959

Detailed Table of Contents 212

SUBJECT INDEX

<i>Adiantum</i>	133
<i>Amoenitatum exoticarum</i>	137
Astacidae	181
Awards	
Academy's Distinguished Service	217
Bacteriology Section in Microbiology	231
J. Shelton Horsley	217
George Washington Engineering	231
<i>Baiera</i>	132
Bequest, Form of	351
Blood Cells, Effects of X-Radiation on,	186
<i>Brontosaurus</i>	131
<i>Cambarus</i>	181-184
<i>C. bartonii bartonii</i>	181
<i>C. bartonii robustus</i>	181, 182
<i>C. bartonii sciotensis</i>	181
<i>C. longulus longulus</i>	181
<i>C. longulus longirostris</i>	181
<i>C. montanus acuminatus</i>	181, 183
<i>Campostoma anomalum</i>	177, 178, 180
<i>C. a. anomalum</i>	177

<i>C. a. kanawhanum</i>	177
<i>C. a. roanokense</i>	177, 180
<i>C. a. virginianum</i>	177
<i>Calystegia</i>	63, 65
<i>C. tomentosa</i>	65, 67
<i>Carya cathayensis</i>	135
<i>Cephalotaxus</i>	139
<i>Cherax</i>	181
Chlorophyta	70
James River, species of	78
Committees	209
Local Arrangements	211
President's Advisory	209
Committee Reports	
Education	364
Flora	234
Journal	224
Junior Academy	225
Long Range Planning	224
Place of Meeting for 1961	234
Research	224
Resolutions	235
Scholarship	234
Science Talent Search	231
Contributors, Notice to	Inside Back Cover
Convolvulaceae	63
<i>Convolvulus</i>	63, 65
<i>C. arvensis</i>	65, 67

<i>C. sepium</i>	63, 65, 67
<i>C. spithameus</i>	63, 65, 67
<i>C. Purshianus</i>	63, 65, 67
Crayfishes, Serological Relationships among	181
Serological comparisons among	183
Council, Membership of	209
<i>Diplodocus</i>	131
Errors Associated with Process Adjustments	3
<i>Euastacus</i>	181
<i>Fagus grandifolia</i>	27, 31
Financial Statement, Journal	223
Follicle, Development in Goats	33
<i>Ginkgo biloba</i>	131-140
Bibliography on,	140-176
<i>var. fastigata</i>	139
<i>var. macrophylea laciniata</i>	139
<i>variegata</i>	139
<i>Ginkgoaceae</i>	139
<i>Ginkgoales</i>	139
<i>Heliscus tentaculus</i>	27, 29, 31
<i>H. aquaticus</i>	30
<i>H. longibrachiatus</i>	30, 31
<i>H. stellatus</i>	30, 31
<i>Ipomoea</i>	65, 67
<i>I. hederacea</i>	65, 68
<i>I. lacunosa</i>	66, 68
<i>I. pandurata</i>	65, 66
<i>I. purpurea</i>	65, 68
James River Basin, Chlorophyta of the	70

<i>Mantissa plantarum</i>	138
Membership	
Application for	351
List of	321
Memorial	
Edwin Morris Betts	1
<i>Metasequoia</i>	134
Minutes	
Academy	216
Conference	216
Council	83, 193, 214, 217
Section	236
Morning Glories	63
Key to Virginia Species of	66
News and Notes	48, 83, 193
<i>Nothotaxus</i>	135
Officers, 1958-1959	102
1959-1960	209
<i>Orconectes</i>	181, 182, 184
<i>O. immunis</i>	181
<i>O. juvenalis</i>	182
<i>O. nais</i>	181
<i>O. propinquis</i>	181
<i>Pacifastacus</i>	181, 182, 184
<i>P. trowbridgii</i>	182
Parastacidae	181
<i>Platanus occidentalis</i>	27, 31
President's Message	48

<i>Procambarus</i>	181, 182, 184
<i>P. blandingii acutus</i>	181
<i>P. clarkii</i>	181
Proceedings (1958-1959)	209
Contents	213
Program — 37th Annual Meeting	101
37th Junior Academy of Science Annual Meeting	105
<i>Pseudolarix</i>	135
Psychological Research in Virginia	91
<i>Quamoclit pennata</i>	65
..... <i>coccinea</i>	65, 67
Research Committee Notice	49
<i>Salisburia adiantifolia</i>	138
Secretary-Treasurer, Report of	220
Section News	49, 86, 195
Sections	
Agriculture	49, 86, 195, 236
Astronomy, Mathematics and Physics	198, 244
Bacteriology	51, 199, 254
Biology	51, 199, 256
Chemistry	53, 87, 201, 265
Education	274
Engineering	55, 87, 203, 277
Geology	58, 89, 289
Medical Sciences	298
Psychology	89, 203, 305
Science Teachers	314
Statistics	61, 97, 207, 316

<i>Sequoia</i>	133
Tabulation of Registration	222
<i>Taxus</i>	139
Teacher Scholarships	231
<i>Torreya</i>	139
<i>Torreya grandis</i>	135
X-Radiation, Effects on Blood Cells	186

AUTHOR INDEX

Abbott, B. J.	177
Franklin, Alicelia Hoskins	131
Freund, Richard A.	3
Howe, William G.	3
Jackson, J. Edward	3
Johnson, Rose Mary	181
Knight, Robert J., III	63
Margolena, Lubow A.	33
Maroney, Samuel P., Jr.	186
Umphlett, Clyde J.	27
Woodson, Bernard, Jr.	70

505, 73
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C O N T E N T S

	<i>Pages</i>
Edwin Morris Betts	1
Errors Associated With Process Adjustments — J. EDWARD JACKSON, RICHARD A. FREUND and WILLIAM G. HOWE	3
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THE VIRGINIA JOURNAL OF SCIENCE

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No. 1

EDWIN MORRIS BETTS
1892-1958

Edwin Morris Betts, Professor of Biology at the University of Virginia, died September 27, 1958 in Charlottesville at the age of 65 years. He was born November 2, 1892 in Raleigh, N. C., son of William C. Betts and Mary Williams Betts. He was graduated from Oxford High School at Oxford, N. C., from the Durham Conservatory of Music and received the Ph.B. degree from Elon College in 1919, the M. S. and Ph.D. degrees from the University of Virginia in 1924 and 1927, respectively. During the summer of 1924 he studied at the Marine Biological Laboratory at Wood's Hole, Mass.

Upon graduation from Elon College he became chairman of the Department of Music there but his interest in plants led him to resign this position to attend the University of Virginia. In 1927, he became Assistant Professor of Biology at the University of Virginia; in 1946, Associate Professor; and in 1950, Professor.

While Mr. Betts' interests were broad, he derived more genuine pleasure in the classroom than in any of his many endeavors. He was an excellent teacher and although an exacting one, his students always knew precisely what was expected of them. His personality and the interest that he demonstrated in each student won for him an enviable measure of respect and admiration.

During the early years of Mr. Betts' teaching his research interests were mainly directed toward the ascomycetes and somewhat later toward megasporogenesis and megagametogenesis in the angiosperms. His broadening interests in the flowering plants led him into a study of the ornamental plants in the vicinity of Charlottesville, and subsequently to the history of the introduction of many of them. Since Thomas Jefferson was responsible for many of these introductions and so many references to plants were included in his various journals, it was a natural sequence that Mr. Betts' interest in Mr. Jefferson's garden and farm should follow. With Mrs. W. Allan Perkins he published "Jefferson's Flower Garden" in 1941, and three years later The American Philosophical Society sponsored publication of his "Jefferson's Garden Book" which was rated one of ten best non-fiction books of 1944. In recognition of the scholarly nature of this

book Mr. Betts was awarded the first Phi Beta Kappa Prize by the University of Virginia Chapter and was made an honorary member of the Society. A Guggenheim Foundation grant enabled Mr. Betts to take time from his teaching to edit "Jefferson's Farm Book" which was also published by the American Philosophical Society in 1953. At the time of his death he was editing a volume including Jefferson's letters to his daughters and their children.

Mr. Betts' familiarity with Jeffersonian documents and his intimate knowledge of plants assured his position on the Restoration Committee for Monticello, and his assistance was invaluable in restoring the gardens at the University. He had accumulated an unusually fine collection of old prints and photographs of the University and Monticello, and had planned to publish the best of them along with annotated notes in book form.

For five years Mr. Betts spent the summers on Nantucket where he was director of the Natural Science Department of the Nantucket Maria Mitchell Association.

With all of his activities, he maintained an active interest in music. An accomplished musician in his own right, he was at various times organist at Christ's and St. Paul's Episcopal Churches, the First Methodist and Westminster Presbyterian Churches.

He was a member of Phi Beta Kappa, Sigma Xi, The Raven Society, Virginia Academy of Science, and the Botanical Society of America, and at one time was Secretary of the General Section of the latter.

Mr. Betts was a scholar and a gentleman, and will long be remembered by his devoted students, his colleagues and friends. He is survived by his widow, the former Miss Mary Hall Stryker; a son, Edwin M. Betts, Jr.; a daughter, Mrs. Hunter C. Lang; and two grandchildren.

— Horton H. Hobbs, Jr. and B. F. D. Runk

ERRORS ASSOCIATED WITH PROCESS ADJUSTMENTS

J. EDWARD JACKSON, *Virginia Polytechnic Institute*¹

RICHARD A. FREUND and WILLIAM G. HOWE, *Eastman Kodak Company*

Introduction

In the last decade, many industrial personnel have paid an increasing degree of attention to the probability of making Type I errors (the probability α of rejecting satisfactory material) and Type II errors (the probability β of accepting material which deviates too greatly from some standard level). These people have often found that a knowledge of these two risks is not enough when a choice must be made between two or more alternate methods of control. They also need to know the probability of making a correct process adjustment in order to maintain precise control. To be more specific, once it has been decided that a process is not operating at its standard level, they wish to know the probabilities involved in making adjustments to return it to standard. In general they estimate the actual process level and then use some function of the difference between this estimate and the standard value to guide their adjustment. This may result in improvements to the process if the adjustment is made in the right direction and in the right amount. On the other hand, if the correction is in the wrong direction or is much too large, the process will be in a poorer state of control than before. In many cases the state of the process would be improved if, within certain bounds (e.g. a zone of stability), it were unadjusted rather than be in an unstable condition due to repeated adjustments.

The purpose of this paper is to associate a probability, γ , with each of the errors of adjustment. Since no adjustments will be made unless the process goes out of control, this amounts to the decomposition of the power curve $(1 - \beta)$ into the following four components:

- γ_1 — the probability of making an undercorrection
- γ_2 — the probability of making a helpful overcorrection
- γ_3 — the probability of making a harmful overcorrection
- γ_4 — the probability of making an adjustment in the wrong direction.

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If β denotes the probability of failing to detect trouble for a given process level, then $\gamma_1 + \gamma_2 + \gamma_3 + \gamma_4 = 1 - \beta$ are the probabilities associated with adjustments to correct the trouble. γ_1 and γ_2 represent the probabilities of improvements to the process while γ_3 and γ_4 represent the probabilities of the process being made worse. Unless the control limits are extremely tight, as would occur when one is willing to increase the α risk to reduce the β risk, the latter two errors will be small.

The Gamma Risks

To state the problem in its simplest terms, let us assume that a process is being monitored by means of a control chart for averages. Whenever the product is sampled and the average of this sample is outside the control limits, an adjustment is made equal to the difference between the sample average and the standard value. A correct adjustment will be made only when the estimate (the sample average) and the true (actual) process level are identical; a situation with a probability of zero. As stated above, if an adjustment is to be made, one of the four following situations must occur:

1) If the adjustment is smaller than necessary, the adjusted process will still be biased on the same side of the standard as before adjustment, but the bias will be smaller. This will happen when the sample average is outside of the control limits but still lies between the actual process level and the standard so that an adjustment of less than $k\sigma_{\bar{X}}$ is made when the process is actually $k\sigma_{\bar{X}}$ from standard. The probability of this undercorrection is:

$$\gamma_1 = P \{ \mu < \bar{X} < L_1 \mid \mu < L_1 \} + P \{ L_2 < \bar{X} < \mu \mid \mu > L_2 \} \quad (1)$$

= 0 otherwise

2) If the adjustment is slightly larger than necessary, the adjusted process will then be biased in the opposite direction, but the absolute bias will be smaller and the process will be improved. This will happen when the sample average is outside of the control limits and lies between $k\sigma_{\bar{X}}$ and $2k\sigma_{\bar{X}}$ from standard although the true process level

¹The following symbols are in standard units (deviations from standard divided by σ):

\bar{X} = Sample mean

μ = True process level

L_1 = Lower control limit

L_2 = Upper control limit

is exactly $k\sigma_{\bar{x}}$ from standard. The probability of this overcorrection is:

$$\gamma_2 = P \left\{ 2\mu < \bar{X} < \min(L_1, \mu) \mid \mu < \frac{L_1}{2} \right\} + P \left\{ \max(L_2, \mu) < \bar{X} < 2\mu \mid \mu > \frac{L_2}{2} \right\} \\ = 0 \text{ otherwise}$$

3) If the adjustment is enough larger than necessary, the adjusted process will be more biased, though in the opposite direction, than it was before adjustment and will be in poorer control. This will happen when the sample average is outside of the control limits and lies more than $2k\sigma_{\bar{x}}$ from standard while the actual process level is only $k\sigma_{\bar{x}}$ from standard. The probability of this overcorrection is:

$$\gamma_3 = P \left\{ \bar{X} < \min(L_1, 2\mu) \mid \mu < 0 \right\} + P \left\{ \bar{X} > \max(L_2, 2\mu) \mid \mu > 0 \right\}$$

4) If the adjustment is in the wrong direction, the adjusted process will be more biased than the original one though in the same direction. This will happen when the sample average is outside of the control limits on the opposite side of standard from the true process level. The probability of this erroneous adjustment is:

$$\gamma_4 = P \left\{ \bar{X} < L_1 \mid \mu > 0 \right\} + P \left\{ \bar{X} > L_2 \mid \mu < 0 \right\}$$

Figure 1 illustrates how, for this particular set of rules for adjustment, the various gamma risks change as the true process level shifts away from standard. This same information is shown graphically in Figure 2. The three graphs represent control limits of $\pm 1\sigma_{\bar{x}}$, $\pm 2\sigma_{\bar{x}}$ and $\pm 3\sigma_{\bar{x}}$ respectively. The calculations associated with this example are shown in Part A of the appendix. When the process level coincides with the standard, $\gamma_1 = \gamma_2 = 0$ and $\gamma_3 = \gamma_4 = \frac{1}{2}\alpha$. (γ_3 and γ_4 are actually undefined for the standard level but each approaches $\alpha/2$ in the limit as μ approaches zero.) γ_3 and γ_4 decrease as wider limits are used. It is interesting to note that whereas the β risk is reduced by shifting from a $3\sigma_{\bar{x}}$ chart to a $1\sigma_{\bar{x}}$ chart (at the price of increasing the α risk), a process whose true level is $\sigma_{\bar{x}}/2$ from standard will be rejected more often. All of these rejections will result in harmful adjustments (γ_3 and γ_4 risks) to the process, and thus are apt to magnify the control problem.

It is believed that the basic concepts implicit in the study of these gamma risks will apply to a large number of problems. For example,

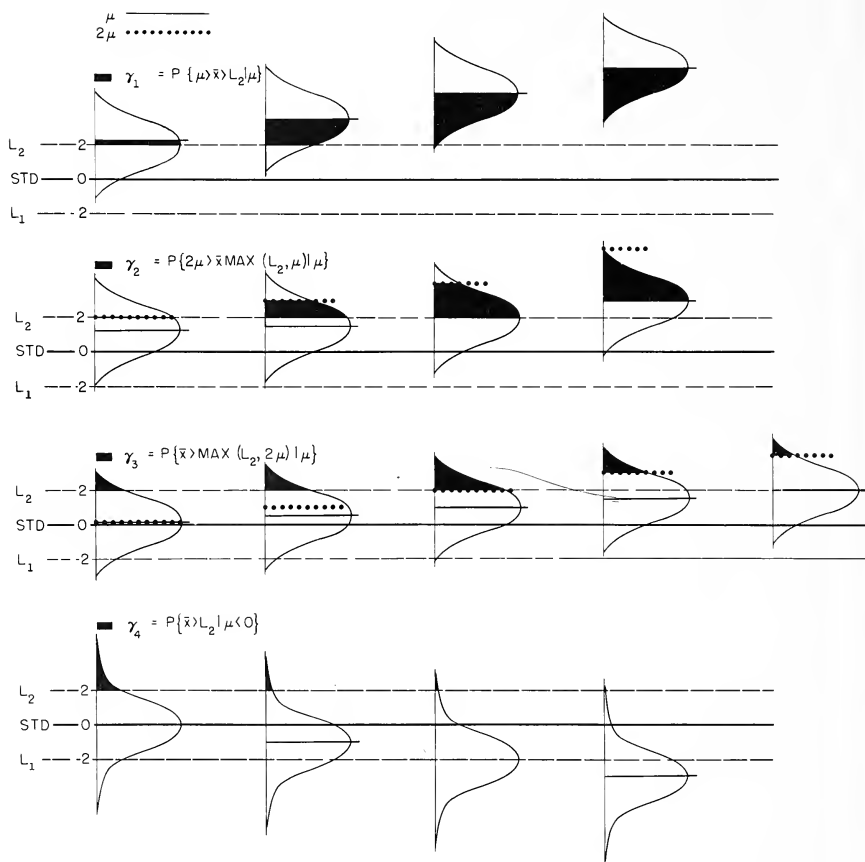


Figure 1. Illustration of γ values for 2σ control charts when \bar{X} falls outside the upper control limit.

in control chart analysis, a study of the gamma values might help decide the most appropriate k for $k\sigma$ limits; whether a run of one, two or more points, or their average must exceed control limits before corrective action is taken; or whether the corrective action should be the full difference between the sample estimate and standard or some fraction thereof. A number of ground rules for adjusting processes are in use today and a study of their α , β , and γ risks should prove quite enlightening. Some examples of a few of the procedures encountered in industry are included in the following section.

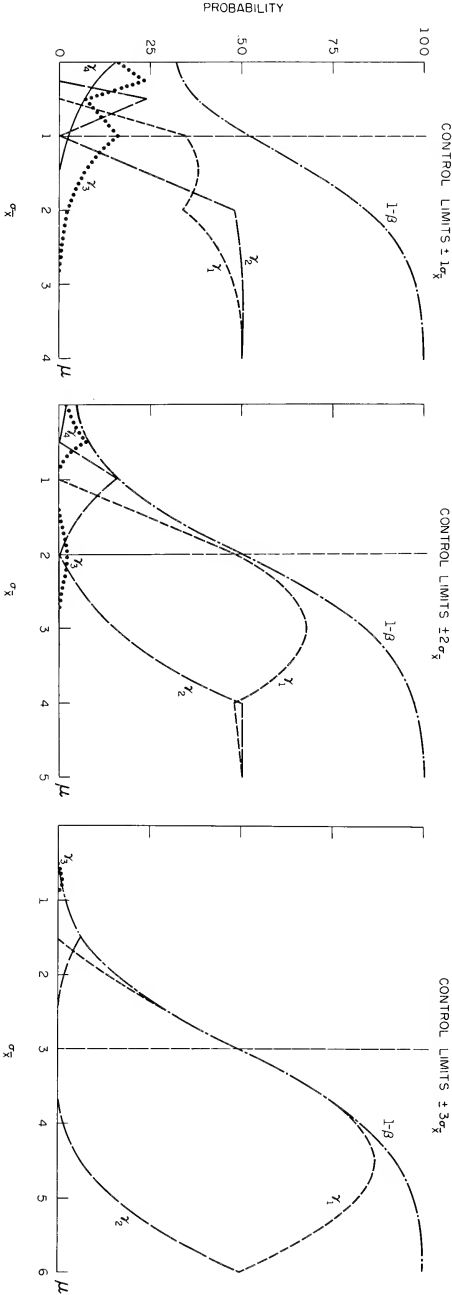


Figure 2. Probability curves for case 1.

Examples

The various process control procedures that will be discussed in this section are included primarily to illustrate this γ -concept rather than to pass on the merits of these procedures as such. As stated above, there are a large number of problems to which this technique may be applied. In addition to those already mentioned there are such things as the effect of process variability between the time the sample is taken and an adjustment is made, the effect of heterogeneity of variance, conditional process adjustments (i.e. on the basis of prior adjustments), run theory, etc. Although the computations required for some of these situations are complicated, they can be handled with the aid of high-speed computers coupled if necessary with the use of the Monte Carlo technique. Some of the simpler examples are given below:

Case 1

The most frequently encountered adjustment procedure is that of correcting by the full amount of the difference between standard and the sample average when the average exceeds the control limits. This case has been discussed above and the probability curves for 1, 2 and $3\sigma_{\bar{x}}$ limits are shown in Figure 2. It is often desirable to substitute the actual value of $\sigma_{\bar{x}}$ for a particular process on the scale for the abscissa since the curves can then be interpreted in terms of the original units, an important feature as far as the experimenter or control man is concerned. In certain cases it is helpful to separate $\sigma_{\bar{x}}^2$ into its components, such as process and measurement variance, and use a scale related to one of these components.

Case 2

One method of reducing the risks of harmful adjustments, while still taking advantage of the benefits of decreased β risks, is to make adjustments which are only a fraction of the difference between the sample mean and the standard value. The ground rules for this case call for adjustments of one-half the difference between the sample average and standard when averages plot between the control limit and twice the control limit, and for full corrections when an average exceeds twice the control limit. The probability curves for this system are shown in Figure 3. The α , β and γ_4 risks are unchanged from Case 1. A comparison of the respective $1\sigma_{\bar{x}}$, $2\sigma_{\bar{x}}$ and $3\sigma_{\bar{x}}$ control charts of Figures 2 and 3 will show that γ_3 , the risk of harmful over-adjustment, is reduced appreciably in the region between one-fourth the distance from the mean

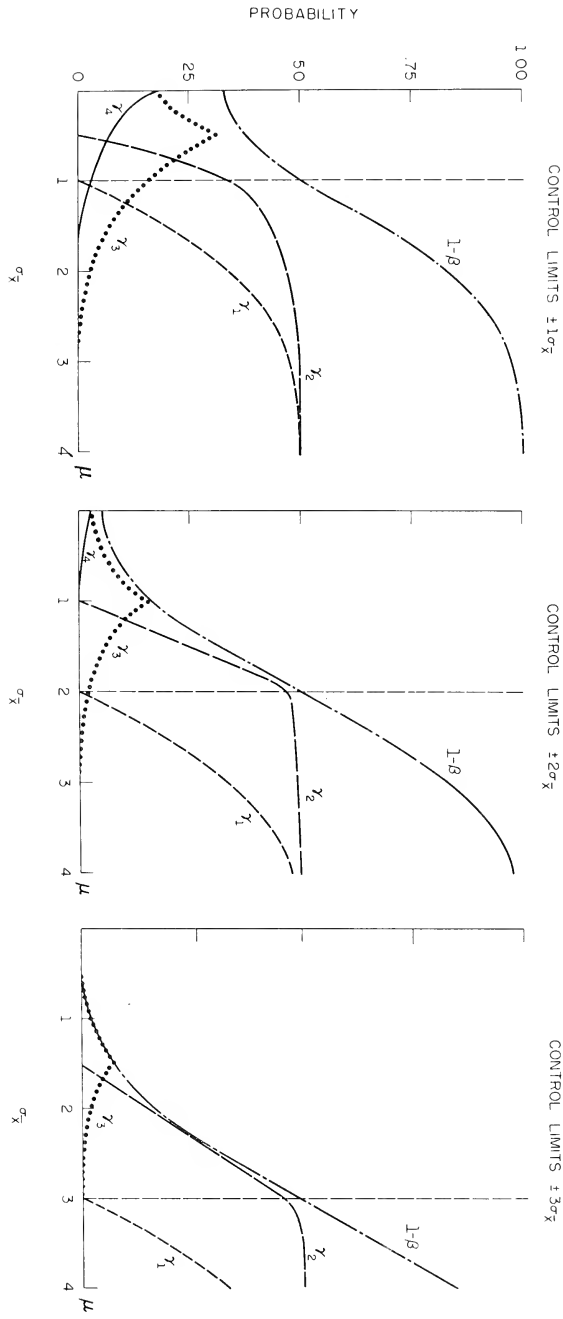


Figure 3. Probability curves for case 2.

to the control limit and the control limit itself. (e.g. for $2\sigma_{\bar{x}}$ limits, this region would go from $\frac{1}{2}\sigma_{\bar{x}}$ to $2\sigma_{\bar{x}}$). This reduction in γ_3 is accompanied by a corresponding increase in γ_2 . γ_2 in turn is reduced in the interval between one-half the distance from the mean to the control limit and twice the control limit (e.g. for $2\sigma_{\bar{x}}$ limits, this region would go from $\sigma_{\bar{x}}$ to $4\sigma_{\bar{x}}$) with a corresponding increase in γ_1 . This is often advantageous in the sense that the process ceases to oscillate as much about the standard, but instead gradually approaches the desired level. The calculations are given in part B of the appendix.

Both cases 1 and 2 are designed for use in those situations in which an assumption of control is reasonable; that is, the process can be expected to run at the standard level subject only to those sources and amounts of variability which are included in the inherent variability term. Whenever the relatively rare event of an assignable cause occurs, the process will be stopped and the assignable cause removed, but as long as the sample averages are inside of the control limits, it is assumed that no assignable causes have entered the system. As processes become more complex, however, it often happens that at least one of a number of possible assignable causes is always present. In effect, the process is never truly in control. For situations like this, it may be desirable to use the system of adjustments described in Case 3.

Case 3

The adjustment procedures for this case call for corrections of one-third the difference between the sample average and standard for averages lying between $1\sigma_{\bar{x}}$ and $2\sigma_{\bar{x}}$; two-thirds correction for averages lying between $2\sigma_{\bar{x}}$ and $3\sigma_{\bar{x}}$; and full corrections for averages outside $3\sigma_{\bar{x}}$. The probability curves for this system are shown in Figure 4. The power curve $1-\beta$ is the same as for a standard $1\sigma_{\bar{x}}$ control chart. Despite the unusual appearance of these curves, a comparison of this illustration with Figures 2 and 3 will show that this system combines the curves for the $1\sigma_{\bar{x}}$, $2\sigma_{\bar{x}}$ and $3\sigma_{\bar{x}}$ charts and produces even greater reductions in the γ_3 risk of overadjustment. The γ_1 risk of underadjustment will be further increased while the low β risk of the $1\sigma_{\bar{x}}$ limit situation is maintained. The calculations are given in part C of the appendix.

Case 4

This final example is a two-sample situation as contrasted to the single samples involved in cases 1 through 3. For example, in the chemical

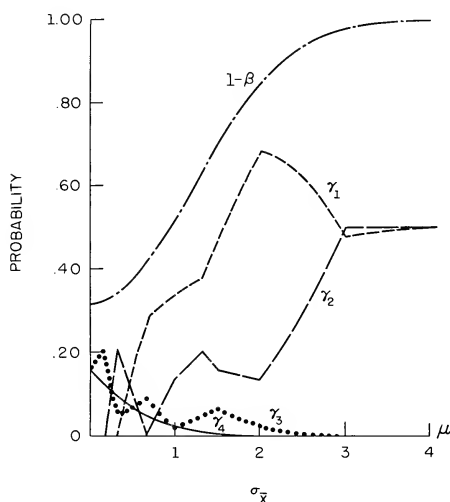


Figure 4. Probability curves for case 3.

laboratory it is often found that the total variance includes a large component of analytical variability in addition to the product variability for which the test is being run. Therefore, when an individual analysis is out of control, the problem arises as to whether it is the constituent level or the analysis which is in error, as well as how large an adjustment is to be made. Naturally, the ratio of σ_A^2 , the analytical variance, to σ_P^2 , the product variance, varies considerably among the many chemicals to be analyzed. The adjustment procedure to be discussed in this example is as follows:

Analyze the sample.

- A. If the result is in control, assume the process to be in control with respect to this constituent.
- B. If the result is out of control, reanalyze and plot the average of the two analyses.
 1. If the average is in control, assume the process to be in control with respect to this constituent.
 2. If the average is out of control, adjust the level of the constituent by an amount equal to the difference between the sample average and the standard.

The control limits for the first analysis should be a multiple of $\sqrt{\sigma_P^2 + \sigma_A^2}$ while those for the average should be a multiple of $\sqrt{\sigma_P^2 + \sigma_A^2/2}$. To make the technique as simple as possible, a satisfactory single limit, $k\sqrt{\sigma_P^2 + \sigma_A^2}$, was used for both charts by compromising on the risks involved (i.e., α and β differ for the first sample and the average of the two samples). The risks which have to be considered are described below. An asterisk after a symbol indicates that the risk is a function of both the first and second analyses.

- α — probability of a reanalysis when the chemical concentration is at its standard level.
- α^* — probability of a process adjustment when the concentration is at its standard level.
- β — probability of failing to call for a reanalysis when the concentration is actually k -sigma from standard.
- β^* — probability of failing to make an adjustment when the concentration is k -sigma from standard.
- γ_1^* — probability of making an underadjustment in which the concentration will still be on the same side of the standard as it was before the correction was applied, although the situation is improved.
- γ_2^* — probability of making an overadjustment in which the concentration will now be on the other side of the standard but not as far from standard as it was before.
- γ_3^* — probability of making an overadjustment to the extent that the concentration is now farther from standard in the opposite direction than before the change was made.
- γ_4^* — probability of making an adjustment in the wrong direction so that the concentration is now farther from standard on the same side than before the correction was made.

These individual terms can be reduced to the four basic probabilities.

- 1 — β = continuing to process without making a second analysis,
- 2 — $\beta^* - \beta$ = reanalyzing but not making a process adjustment,
- 3 — $\gamma_1^* + \gamma_2^*$ = making a process adjustment which improves the process,
- 4 — $\gamma_3^* + \gamma_4^*$ = making a process adjustment which harms the process.

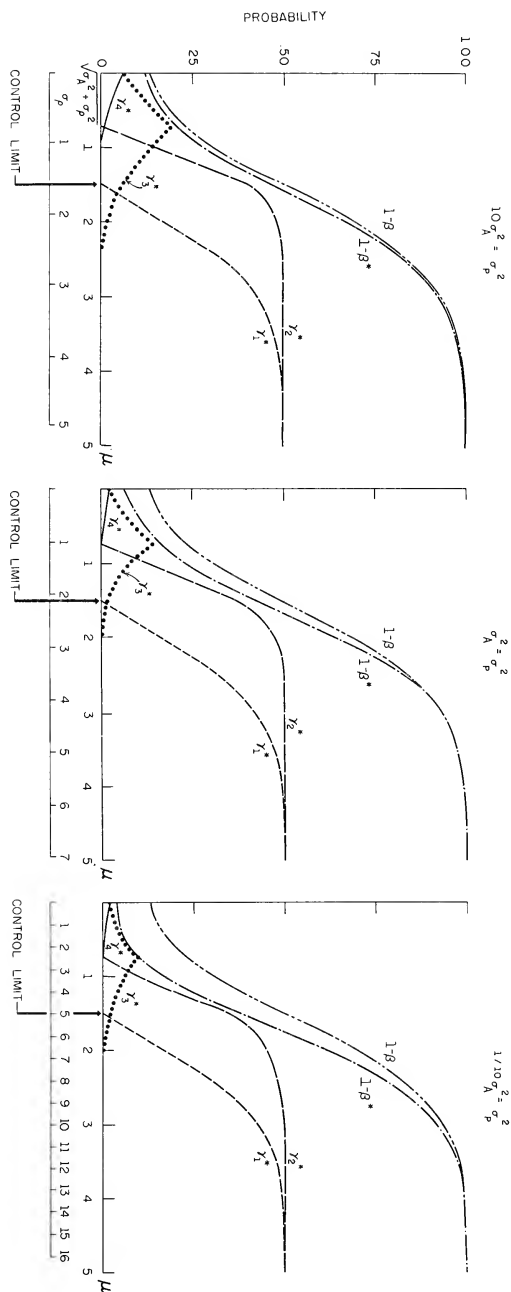


Figure 5. Probability curves for case 4.
Control limits $\equiv \pm 3.0\sqrt{\sigma_A^2 + \sigma_P^2}$

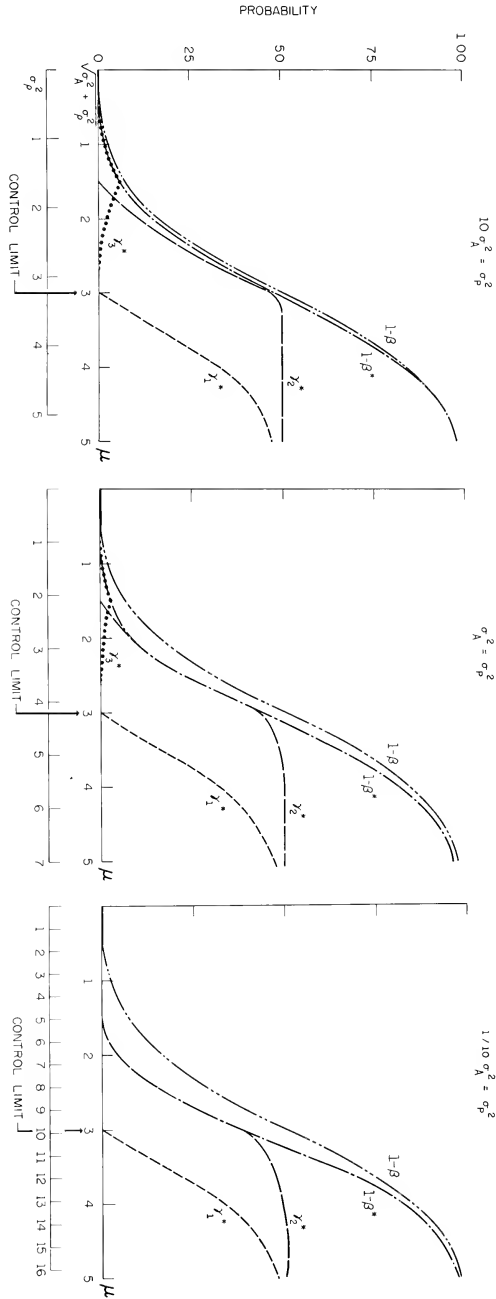


Figure 6. Probability curves for case 4.
Control limits $\equiv \pm 1.5\sqrt{\sigma_A^2 + \sigma_P^2}$

Figure 5 shows the values of the various risks of error for three combinations of $(\sigma_P^2 + \sigma_A^2)$ using control limits of $\pm 3 \sqrt{\sigma_P^2 + \sigma_A^2}$. The three combinations are: 1) $10\sigma_A^2 = \sigma_P^2$; 2) $\sigma_A^2 = \sigma_P^2$; 3) $(1/10)\sigma_A^2 = \sigma_P^2$. Figure 6 shows these same risks using $1.5 \sqrt{\sigma_P^2 + \sigma_A^2}$ control limits. The scales for Figures 5 and 6 are given in terms of both $\sqrt{\sigma_P^2 + \sigma_A^2}$ and σ_P . The latter will be of most interest to the chemist. The calculations are given in part D of the appendix.

Reference

Pearson, Karl. "Tables for Statisticians and Biometricians, Parts I and II", Cambridge University Press, London (1930 and 1931).

Appendix ²

A. Formulas for case 1:

Let

std = center line on control chart

$$L_1 = \frac{\text{lower control limit} - \text{std}}{\sigma_{\bar{X}}}$$

$$L_2 = \frac{\text{upper control limit} - \text{std}}{\sigma_{\bar{X}}}$$

$$\mu = \frac{\text{population mean} - \text{std}}{\sigma_{\bar{X}}}$$

 \bar{X} = sample mean in standard unit $f(x)$ = normal distribution function

$$= \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}x^2} \text{ so that } \int f(x)dx$$

can be obtained in any table of normal deviates.

$$\alpha = P\{\bar{X} < L_1 \mid \mu = 0\} + P\{\bar{X} > L_2 \mid \mu = 0\} = \int_{-\infty}^{L_1} f(x) dx + \int_{L_2}^{\infty} f(x) dx$$

$$\beta = 1 - P\{\bar{X} < L_1 \mid \mu\} - P\{\bar{X} > L_2 \mid \mu\} = 1 - \int_{-\infty}^{L_1 - \mu} f(x) dx - \int_{L_2 - \mu}^{\infty} f(x) dx$$

The limits of integration for γ_1 , γ_2 , and γ_3 , which vary with μ , are shown in Table I.

$$\gamma_1 = P\{\mu < \bar{X} < L_1 \mid \mu < L_1\} + P\{L_2 < \bar{X} < \mu \mid \mu > L_2\}$$

$$= 0 \text{ otherwise}$$

$$\gamma_2 = P\{2\mu < \bar{X} < \min(L_1, \mu) \mid \mu < L_1/2\} + P\{\max(L_2, \mu) < \bar{X} < 2\mu \mid \mu > L_2/2\}$$

$$= 0 \text{ otherwise}$$

²Only inequalities are shown in most of these probability statements because the control situations result in discontinuous functions. The probability of these equalities is zero.

$$\gamma_3 = P \{ \bar{X} < \min(L_1, 2\mu) \mid \mu < 0 \} + P \{ \bar{X} > \max(L_2, 2\mu) \mid \mu > 0 \}$$

$$\gamma_4 = P \{ \bar{X} < L_1 \mid \mu > 0 \} + P \{ \bar{X} > L_2 \mid \mu < 0 \}$$

$$= \int_{L_2 - \mu}^{\infty} f(x) dx \quad \mu < 0$$

$$= \int_{-\infty}^{L_1 - \mu} f(x) dx \quad \mu > 0.$$

B. Formulas for case 2:

L_1 , L_2 , μ , \bar{X} and $f(x)$ are defined the same as in case 1. α , β and γ_4 are determined in the same way as in case 1. The limits of integration for the remaining γ - risks are shown in Table I.

$$\begin{aligned} \gamma_1 &= P \{ \min(2L_1, \mu) < \bar{X} < L_1 \mid \mu < L_1 \} + P \{ 2\mu < \bar{X} < L_1 \mid L_1 < \mu < L_1/2 \} \\ &+ P \{ L_2 < \bar{X} < 2\mu \mid L_2/2 < \mu < L_2 \} + P \{ L_2 < \bar{X} < \max(2L_2, \mu) \mid L_2 < \mu \} \\ &= 0 \text{ otherwise} \end{aligned}$$

$$\begin{aligned} \gamma_2 &= P \{ 2\mu < \bar{X} < \min(2L_1, \mu) \mid \mu < L_1 \} + P \{ 2L_1 < \bar{X} < 2\mu \mid L_1 < \mu < L_1/2 \} \\ &+ P \{ 4\mu < \bar{X} < L_1 \mid L_1/2 < \mu < L_1/4 \} + P \{ L_2 < \bar{X} < 4\mu \mid L_2/4 < \mu < L_2/2 \} \\ &+ P \{ 2\mu < \bar{X} < 2L_2 \mid L_2/2 < \mu < L_2 \} + P \{ \max(2L_2, \mu) < \bar{X} < 2\mu \mid L_2 < \mu \} \\ &= 0 \text{ otherwise} \end{aligned}$$

$$\begin{aligned} \gamma_3 &= P \{ \bar{X} < \min(2L_1, 2\mu) \mid \mu < L_1/2 \} + P \{ \bar{X} < \min(L_1, 4\mu) \mid L_1/2 < \mu < 0 \} \\ &+ P \{ \bar{X} > \max(L_2, 4\mu) \mid 0 < \mu < L_2/2 \} + P \{ \bar{X} > \max(2L_2, 2\mu) \mid L_2/2 < \mu \}. \end{aligned}$$

C. Formuas for case 3:

$L_1, L_2, \mu, X, f(x), \alpha, \beta$, and γ_4 are the same as in cases 1 and 2. The limits of integration for the remaining γ - risks are shown in Table 1. For the example given in case 3, $L_1 = -\sigma$ and $L_2 = +\sigma$.

$$\begin{aligned} \gamma_1 = & P \{ \min(3L_1, \mu) < X < L_1 \mid \mu < 2L_1 \} + P \{ 3\mu/2 < X < L_1 \mid 2L_1 < \mu < 4L_1/3 \} \\ & + P \{ \min(3\mu, 2L_1) < X < L_1 \mid 4L_1/3 < \mu < L_1/3 \} \\ & + P \{ L_2 < X < \min(3\mu, 2L_2) \mid L_2/3 < \mu < 4L_2/3 \} \\ & + P \{ L_2 < X < 3\mu/2 \mid 4L_2/3 < \mu < 2L_2 \} + P \{ L_2 < X < \max(3L_2, \mu) \mid 2L_2 < \mu \} \\ & = 0 \text{ otherwise} \end{aligned}$$

$$\begin{aligned} \gamma_2 = & P \{ 2\mu < X < \mu \mid \mu < 3L_1 \} + P \{ 2\mu < X < \max(3\mu/2, 3L_1) \mid 3L_1 < \mu < 3L_1/2 \} \\ & + P \{ 3L_1 < X < 3\mu/2 \mid 3L_1/2 < \mu < 4L_1/3 \} \\ & + P \{ \max(3\mu, 3L_1) < X < 2L_1 \mid 4L_1/3 < \mu < 2L_1/3 \} \\ & + P \{ 2L_1 < X < 3\mu \mid 2L_1/3 < \mu < L_1/3 \} + P \{ 6\mu < X < L_1 \mid L_1/3 < \mu < L_1/6 \} \\ & + P \{ L_2 < X < 6\mu \mid L_2/6 < \mu < L_2/3 \} + P \{ 3\mu < X < 2L_2 \mid L_2/3 < \mu < 2L_2/3 \} \\ & + P \{ 2L_2 < X < \min(3\mu, 3L_2) \mid 2L_2/3 < \mu < 4L_2/3 \} \\ & + P \{ 3\mu/2 < X < 3L_2 \mid 4L_2/3 < \mu < 3L_2/2 \} \\ & + P \{ \min(3\mu/2, 3L_2) < X < 2\mu \mid 3L_2/2 < \mu < 3L_2 \} + P \{ \mu < X < 2\mu \mid 3L_2 < \mu \} \\ & = 0 \text{ otherwise} \end{aligned}$$

$$\begin{aligned} \gamma_3 = & P \{ X < \min(3L_1, 2\mu) \mid \mu < L_1 \} + P \{ X < \min(2L_1, 3\mu) \mid L_1 < \mu < L_1/3 \} \\ & + P \{ X < \min(L_1, 6\mu) \mid L_1/3 < \mu < 0 \} + P \{ X > \max(L_2, 6\mu) \mid 0 < \mu < L_2/3 \} \end{aligned}$$

$$+ P \{ X > \max(2L_2, 3\mu) \mid L_2/3 < \mu < L_2 \} + P \{ X > \max(3L_2, 2\mu) \mid L_2 < \mu \}.$$

D. Formulas for case 4:

Let: σ_A^2 = analytical variability

σ_P^2 = process variability

$\sigma_T^2 = \sigma_A^2 + \sigma_P^2$ = total variability since analytical and process variabilities are independent

$\rho = \sigma_P^2 / (\sigma_P^2 + \sigma_A^2)$ = correlation between first and second analysis

$q = \sigma_P^2 / \sigma_A^2$ = ratio of process to analytical variability

ν = population mean

a_1 = result of first analysis

a_2 = result of second analysis

$\bar{a} = (a_1 + a_2)/2$

X_1 = result of first analysis in standard units

$$= \frac{a_1 - \text{std}}{\sqrt{\sigma_A^2 + \sigma_P^2}}$$

$$\bar{X} = \bar{a} \text{ in standard units, i.e.: } \frac{\bar{a} - \text{std.}}{\sqrt{\sigma_A^2 + \sigma_P^2}}$$

μ = population mean in standard units

L_1 = lower control limit in standard units

L_2 = upper control limit in standard units

$f(x)$ = normal deviates as used in cases 1, 2, and 3.

$$g(a_1, \bar{a}) = \frac{1}{\pi \sigma_A \sqrt{\sigma_A^2 + 2\sigma_P^2}} e^{-\left[\frac{\sigma_A^2 + \sigma_P^2}{\sigma_A^2} \right] \left[\frac{(a_1 - \nu)^2 - 2(a_1 - \nu)(\bar{a} - \nu)}{\sigma_A^2 + \sigma_P^2} + \frac{2(\bar{a} - \nu)^2}{\sigma_A^2 + 2\sigma_P^2} \right]}$$

= joint distribution of the first analysis and the average of both analyses.

To simplify the computations, let:

$$y = \frac{a_1 - \nu}{\sqrt{\sigma_A^2 + \sigma_P^2}}$$

$$z = \frac{\bar{a} - \nu}{\sqrt{\frac{\sigma_A^2 + 2\sigma_P^2}{2}}}$$

$$\omega = \frac{\sqrt{\sigma_A^2 + 2\sigma_P^2}}{\sqrt{2(\sigma_A^2 + \sigma_P^2)}}$$

so that the resultant distribution is:

$$g(y, z) = \frac{1}{2\pi\sqrt{1-\omega^2}} e^{-\frac{1}{2}\left[\frac{1}{1-\omega^2}\right]\left[y^2 - 2\omega yz + z^2\right]}$$

which is tabulated in Karl Pearson's "Tables for Statisticians and Biometricians."

Type I Errors

α = probability of an unnecessary analysis: same as in cases 1, 2 and 3.

α^0 = probability of an unnecessary process adjustment:

$$= P\{X_1 < L_1, X < L_1 \mid \mu = 0\} + P\{X_1 < L_1, X > L_2 \mid \mu = 0\}$$

$$+ P\{X_1 > L_2, X < L_1 \mid \mu = 0\} + P\{X_1 > L_2, \bar{X} > L_2 \mid \mu = 0\}$$

$$= \int_{-\infty}^{L_1} \int_{-\infty}^{\frac{L_1}{\omega}} g(y, z) dz dy + \int_{-\infty}^{L_1} \int_{\frac{L_2}{\omega}}^{\infty} g(y, z) dz dy$$

$$+ \int_{L_2}^{\infty} \int_{-\infty}^{\frac{L_1}{\omega}} g(y, z) dz dy + \int_{L_2}^{\infty} \int_{\frac{L_2}{\omega}}^{\infty} g(y, z) dz dy$$

Type II Errors

β = probability of not reanalyzing: same as cases 1, 2, and 3.

β^* = probability of not adjusting process:

$$= P \{ L_1 < X_1 < L_2 \mid \mu \} + P \{ X_1 < L_1, L_1 < \bar{X} < L_2 \mid \mu \} \\ + P \{ X_1 > L_2, L_1 < \bar{X} < L_2 \mid \mu \}$$

$$= \beta + \int_{-\infty}^{L_1 - \mu} \int_{\frac{L_1 - \mu}{\omega}}^{\frac{L_2 - \mu}{\omega}} g(y, z) dz dy + \int_{L_2 - \mu}^{\infty} \int_{\frac{L_1 - \mu}{\omega}}^{\frac{L_2 - \mu}{\omega}} g(y, z) dz dy$$

Errors of Adjustment

γ_1^* = Probability of making an under-adjustment on the same side of the standard

$$= P \{ X_1 < L_1, \mu < \bar{X} < L_1 \mid \mu < L_1 \} + P \{ X_1 > L_2, \mu < \bar{X} < L_1 \mid \mu < L_1 \} \\ + P \{ X_1 < L_1, L_2 < \bar{X} < \mu \mid \mu > L_2 \} + P \{ X_1 > L_2, L_2 < \bar{X} < \mu \mid \mu > L_2 \} \\ = 0 \text{ otherwise}$$

$$= \int_{-\infty}^{L_1 - \mu} \int_0^{\frac{L_1 - \mu}{\omega}} g(y, z) dz dy + \int_{L_2 - \mu}^{\infty} \int_0^{\frac{L_1 - \mu}{\omega}} g(y, z) dz dy \quad \mu < L_1$$

$$= \int_{-\infty}^{L_1 - \mu} \int_{\frac{L_2 - \mu}{\omega}}^0 g(y, z) dz dy + \int_{L_2 - \mu}^{\infty} \int_{\frac{L_2 - \mu}{\omega}}^0 g(y, z) dz dy \quad \mu > L_2$$

γ_2^* = probability of making an underadjustment on the opposite side of the standard

$$= P \{ X_1 < L_1, 2\mu < \bar{X} < \min(L_1, \mu) \mid \mu < L_1/2 \}$$

$$+ P \{ X_1 > L_2, 2\mu < \bar{X} < \min(L_1, \mu) \mid \mu < L_1/2 \}$$

$$+ P \{ X_1 < L_1, \max(L_2, \mu) < \bar{X} < 2\mu \mid \mu > L_2/2 \}$$

$$+ P \{ X_1 > L_2, \max(L_2, \mu) < \bar{X} < 2\mu \mid \mu > L_2/2 \}$$

$$= 0 \text{ otherwise}$$

$$= \int_{-\infty}^{L_1 - \mu} \int_{\frac{\mu}{\omega}}^0 g(y, z) dz dy + \int_{L_2 - \mu}^{\infty} \int_{\frac{\mu}{\omega}}^0 g(y, z) dz dy \quad \mu < L_1$$

$$= \int_{-\infty}^{L_1 - \mu} \int_{\frac{\mu}{\omega}}^{\frac{L_1 - \mu}{\omega}} g(y, z) dz dy + \int_{L_2 - \mu}^{\infty} \int_{\frac{\mu}{\omega}}^{\frac{L_1 - \mu}{\omega}} g(y, z) dz dy \quad L_1 < \mu < L_1/2$$

$$= \int_{-\infty}^{L_1 - \mu} \int_{\frac{L_2 - \mu}{\omega}}^{\frac{\mu}{\omega}} g(y, z) dz dy + \int_{L_2 - \mu}^{\infty} \int_{\frac{L_2 - \mu}{\omega}}^{\frac{\mu}{\omega}} g(y, z) dz dy \quad L_2/2 < \mu < L_2$$

$$= \int_{-\infty}^{L_1 - \mu} \int_0^{\frac{\mu}{\omega}} g(y, z) dz dy + \int_{L_2 - \mu}^{\infty} \int_0^{\frac{\mu}{\omega}} g(y, z) dz dy \quad L_2 < \mu$$

γ_3^* = Probability of making an overadjustment

$$= P \{ X_1 < L_1, \bar{X} < \min(L_1, 2\mu) \mid \mu < 0 \}$$

$$+ P \{ X_1 > L_2, \bar{X} < \min(L_1, 2\mu) \mid \mu < 0 \}$$

$$+ P \{ X_1 < L_1, \bar{X} > \max(L_2, 2\mu) \mid \mu > 0 \}$$

$$+ P \{ X_1 > L_2, \bar{X} > \max(L_2, 2\mu) \mid \mu > 0 \}$$

$$= \int_{-\infty}^{L_1-\mu} \int_{-\infty}^{\frac{\mu}{\omega}} g(y, z) dz dy + \int_{L_2-\mu}^{\infty} \int_{-\infty}^{\frac{\mu}{\omega}} g(y, z) dz dy \quad \mu < L_1/2$$

$$= \int_{-\infty}^{L_1-\mu} \int_{-\infty}^{\frac{L_1-\mu}{\omega}} g(y, z) dz dy + \int_{L_2-\mu}^{\infty} \int_{-\infty}^{\frac{L_1-\mu}{\omega}} g(y, z) dz dy \quad L_1/2 < \mu < 0$$

$$= \int_{-\infty}^{L_1-\mu} \int_{\frac{L_2-\mu}{\omega}}^{\infty} g(y, z) dz dy + \int_{L_2-\mu}^{\infty} \int_{\frac{L_2-\mu}{\omega}}^{\infty} g(y, z) dz dy \quad 0 < \mu < L_2/2$$

$$= \int_{-\infty}^{L_1-\mu} \int_{\frac{\mu}{\omega}}^{\infty} g(y, z) dz dy + \int_{L_2-\mu}^{\infty} \int_{\frac{\mu}{\omega}}^{\infty} g(y, z) dz dy \quad \mu > L_2/2$$

γ_4^* = Probability of making an adjustment in the wrong direction

$$= P \{ X_1 < L_1, \bar{X} > L_2 \mid \mu < 0 \} + P \{ X_1 > L_2, \bar{X} > L_2 \mid \mu < 0 \}$$

$$= P \{ X_1 < L_1, \bar{X} < L_1 \mid \mu > 0 \} + P \{ X_1 > L_2, \bar{X} < L_1 \mid \mu > 0 \}$$

$$= \int_{-\infty}^{L_1 - \mu} \int_{\frac{L_2 - \mu}{\omega}}^{\infty} g(y, z) dz dy + \int_{L_2 - \mu}^{\infty} \int_{\frac{L_2 - \mu}{\omega}}^{\infty} g(y, z) dz dy \quad \mu < 0$$

$$= \int_{-\infty}^{L_1 - \mu} \int_{-\infty}^{\frac{L_1 - \mu}{\omega}} g(y, z) dz dy + \int_{L_2 - \mu}^{\infty} \int_{-\infty}^{\frac{L_1 - \mu}{\omega}} g(y, z) dz dy \quad \mu > 0$$

Table 1
Limits of Integration for

		Case 1					
		γ_1		γ_2		γ_3	
μ		Lower	Upper	Lower	Upper	Lower	Upper
Bound	Bound	Limit	Limit	Limit	Limit	Limit	Limit
$-\infty$	L_1	$L_1 - \mu$	0	0	μ	μ	$-\infty$
L_1	$L_1/2$	#	#	$L_1 - \mu$	μ	μ	$-\infty$
$L_1/2$	0	#	#	#	#	$L_1 - \mu$	$-\infty$
0	$L_2/2$	#	#	#	#	∞	$L_2 - \mu$
$L_2/2$	L_2	#	#	μ	$L_2 - \mu$	∞	μ
L_2	∞	0	$L_2 - \mu$	μ	0	∞	μ
		Case 2					
		γ_1		γ_2		γ_3	
μ		Lower	Upper	Lower	Upper	Lower	Upper
Bound	Bound	Limit	Limit	Limit	Limit	Limit	Limit
$-\infty$	$2L_1$	$L_1 - \mu$	0	0	μ	μ	$-\infty$
$2L_1$	L_1	$L_1 - \mu$	$2L_1 - \mu$	$2L_1 - \mu$	μ	μ	$-\infty$
L_1	$L_1/2$	$L_1 - \mu$	μ	μ	$2L_1 - \mu$	$2L_1 - \mu$	$-\infty$
$L_1/2$	$L_1/4$	#	#	$L_1 - \mu$	3μ	3μ	$-\infty$
$L_1/4$	0	#	#	#	#	$L_1 - \mu$	$-\infty$
0	$L_2/4$	#	#	#	#	∞	$L_2 - \mu$
$L_2/4$	$L_2/2$	#	#	3μ	$L_2 - \mu$	∞	3μ
$L_2/2$	L_2	μ	$L_2 - \mu$	$2L_2 - \mu$	μ	∞	$2L_2 - \mu$
L_2	$2L_2$	$2L_2 - \mu$	$L_2 - \mu$	μ	$2L_2 - \mu$	∞	μ
$2L_2$	∞	0	$L_2 - \mu$	μ	0	∞	μ

These risks do not exist for these values of μ .

Case 3

μ		γ_1		γ_2		γ_3	
Lower Bound	Upper Bound	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit
$-\infty$	$3L_1$	$L_1 - \mu$	0	0	μ	μ	$-\infty$
$3L_1$	$2L_1$	$L_1 - \mu$	$3L_1 - \mu$	$3L_1 - \mu$	μ	μ	$-\infty$
$2L_1$	$3L_1/2$	$L_1 - \mu$	$\mu/2$	$\mu/2$	μ	μ	$-\infty$
$3L_1/2$	$4L_1/3$	$L_1 - \mu$	$\mu/2$	$\mu/2$	$3L_1 - \mu$	$3L_1 - \mu$	$-\infty$
$4L_1/3$	L_1	$L_1 - \mu$	$2L_1 - \mu$	$2L_1 - \mu$	$3L_1 - \mu$	$3L_1 - \mu$	$-\infty$
L_1	$2L_1/3$	$L_1 - \mu$	$2L_1 - \mu$	$2L_1 - \mu$	2μ	2μ	$-\infty$
$2L_1/3$	$L_1/3$	$L_1 - \mu$	2μ	2μ	$2L_1 - \mu$	$2L_1 - \mu$	$-\infty$
$L_1/3$	$L_1/6$	#	#	$L_1 - \mu$	5μ	5μ	$-\infty$
$L_1/6$	0	#	#	#	#	$L_1 - \mu$	$-\infty$
0	$L_2/6$	#	#	#	#	∞	$L_2 - \mu$
$L_2/6$	$L_2/3$	#	#	5μ	$L_2 - \mu$	∞	5μ
$L_2/3$	$2L_2/3$	2μ	$L_2 - \mu$	$2L_2 - \mu$	2μ	∞	$2L_2 - \mu$
$2L_2/3$	L_2	$2L_2 - \mu$	$L_2 - \mu$	2μ	$2L_2 - \mu$	∞	2μ
L_2	$4L_2/3$	$2L_2 - \mu$	$L_2 - \mu$	$3L_2 - \mu$	$2L_2 - \mu$	∞	$3L_2 - \mu$
$4L_2/3$	$3L_2/2$	$\mu/2$	$L_2 - \mu$	$3L_2 - \mu$	$\mu/2$	∞	$3L_2 - \mu$
$3L_2/2$	$2L_2$	$\mu/2$	$L_2 - \mu$	μ	$\mu/2$	∞	μ
$2L_2$	$3L_2$	$3L_2 - \mu$	$L_2 - \mu$	μ	$3L_2 - \mu$	∞	μ
$3L_2$	∞	0	$L_2 - \mu$	μ	0	∞	μ

These risks do not exist for these values of μ .

HELISCUS TENTACULUS, n. sp., AN AQUATIC HYPHOMYCETE¹

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During a recent preliminary survey of the aquatic Hyphomycete flora of Montgomery County, Virginia, (Umphlett, 1957) an undescribed fungus was found growing on submerged, decaying leaves of *Platanus occidentalis* and *Fagus grandifolia*. The fungus was found in two collections made in January, 1957, and was not observed in collections made at any other time during the year. Growth of the organism on the leaves was rather sparse. Usually only about a dozen sporophores were seen on any single leaf. On *Platanus* growth was restricted to the petiole, but on *Fagus* the sporophores appeared also along the margins of the blade.

HELISCUS TENTACULUS, sp. nov.

Fungus aquaticus submersus, mycelio ramoso, septato. Sporophoro hyalino, 38-100 μ longo, 3-4 μ lato, terminante in catervam phialidum, 26-52 μ longo, 3-5 μ lato. Phialosporo hyalino, aseptato, ramoso, clavata basi, 45-71 μ longa, 1.5-2.0 μ lata ad radices, 5-7 μ lata ad apicem, et tribus tenuibus ramosis emergentibus simul ad apicem; liberato post fabricatum septum ad basium spori.

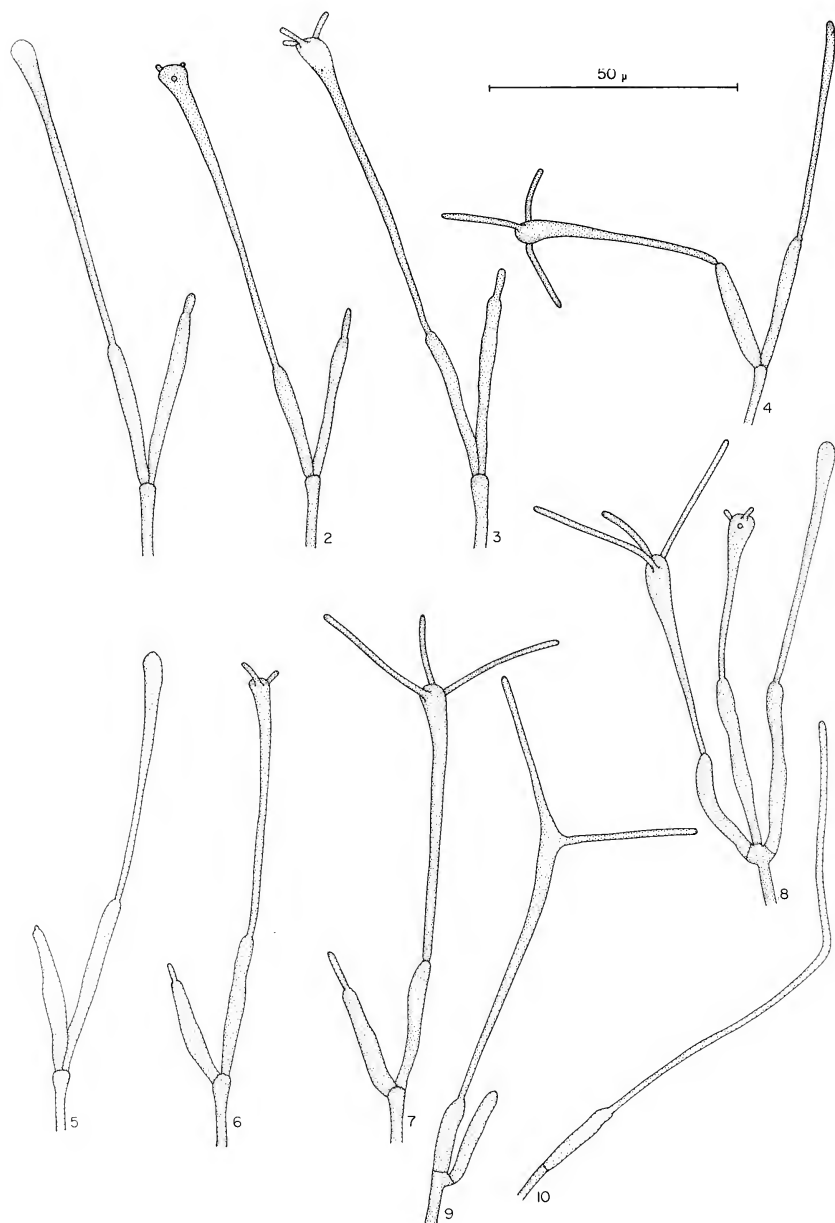
In foliis putrescentibus *Platanus occidentalis* in Mill Creek, Montgomery County, Virginia.

HELISCUS TENTACULUS, n. sp.

Submerged aquatic fungus with branched, septate mycelium. Sporophores hyaline, 38-100 μ long, 3-4 μ broad, branched near the distal end to form one or more groups of phialides, 26-52 μ long, 3-5 μ broad. Phialospores hyaline, unicellular, branched, each consisting of an elongate, clavate basal portion, 45-71 μ long, 1.5-2.0 μ broad at the point of attachment to the phialide, broadening to 5-7 μ at the apex, and three slender divergent branches, 33-43 μ long, arising simultaneously at points equidistant from one another on the broadest portion of the apex; spores produced in basipetal succession from the phialides; liberated by disarticulation at a septum formed at the point of attachment of the mature spore to the phialide.

¹ This paper constitutes a portion of a thesis submitted to the Graduate Faculty of the Virginia Polytechnic Institute in partial fulfillment of the requirements for the degree of Master of Science in Botany.

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On submerged, decaying leaves of *Plantus occidentalis* in Mill Creek, Montgomery County, Virginia.

As in other aquatic Hyphomycetes the mycelium of *Heliscus tentaculus* develops within the vascular systems of the submerged leaves which serve as its substratum. The sporophores arise from these internal hyphae, penetrate the leaf tissues and protrude at right angles into the water. The sporophores with developing phialospores are very conspicuous by their length. The combined length of the sporophore, phialide, and phialospore may be as much as 225μ in which case the phialospore is extended into the water at a distance considerably greater than the comparable structures of other species observed growing on the same substratum.

The phialospore is initiated as a slender, hypha-like extension, $1.5-2.0\mu$ thick, from the apex of the phialide (figs. 1-4). As apical elongation of the extension continues the end of this structure becomes noticeably swollen, and soon the spore primordium has become clavate (fig. 5). When the clavate primordium has attained its mature length of $45-71\mu$, elongation of this basal portion ceases. Then three divergent protuberances arise simultaneously at points equidistant from one another on the swollen apex (fig. 6). Simultaneous elongation of these slender protuberances produces the three divergent branches of the mature phialospore (fig. 7). When the spore is fully mature, a septum forms at its base and liberation occurs by a gradual disarticulation at this septum.

In some instances phialides were observed which had produced normal spores previously, but which gave rise subsequently to abnormal struct-

EXPLANATION OF FIGURES

Figs. 1-7. *Heliscus tentaculus*, showing spore development. 1. Tip of a sporophore with two phialides; on left is a clavate spore primordium; on right is a primordium just beginning to develop, 11:50 A.M. 2. Initiation of three branches of spore at left, 12:05 P.M. 3. Same spores at 1:05 P.M. 4. Spore on left is being liberated; primordium on right continues elongation, 4:00 P. M. 5. Primordium on right is now clavate, 4:30 P.M. 6. Branches developing on spore at right, 5:30 P.M. 7. Spore on right is mature, septum has formed at base; primordium on left is elongating, 6:15 P.M. Figs. 8-10. *Heliscus tentaculus*. 8. Tip of sporophore branch showing three phialides with spores each of which is in a different stage of development. 9. Abnormal spore with only two divergent branches. 10. Abnormally functioning phialide producing a bent hypha-like structure instead of a typical phialospore. All figs. from hanging-drop cultures on bits of *Platanus occidentalis* leaves. All figs. drawn with the aid of a camera lucida. All X670.

ures. In one case a spore with only two divergent branches was produced (fig. 9.). This spore was liberated in the normal manner. In another case the structure produced did not differentiate into the typical clavate basal portion of a spore, but rather it had the appearance of a slender, bent hypha growing from the tip of the phialide (fig. 10). This structure was not observed to separate from the phialide.

Repeated attempts to isolate this fungus in pure culture were unsuccessful. The phialospores germinated readily in water, but no germination was observed on the malt agar medium employed successfully for isolation of other species of aquatic Hyphomycetes. In water a slender germ tube was produced from the base of the spore and from any or all of the divergent branches.

The present fungus is placed in the genus *Heliscus* Saccardo with some reservation. Ingold (1942) and Ingold and Cox (1957) have described three species of aquatic Typhomycetes which they refer to that genus. One, *H. aquaticus* Ing., conforms well to the original generic description of Saccardo (1880) in that sporodochia are formed and the spores are phialospores. However, the two other species, *H. longibrachiatus* Ing., and *H. stellatus* Ing. and Cox, are referred to the same genus on the basis of developmental and morphological similarities of the phialospores. Sporodochia have not been observed in either of the latter two species. Likewise, in *H. tentaculus* sporodochia are unknown. Spore development and morphology are essentially the same in this species as in the three British species. In all the species the spores develop from phialides, and at maturity the spores of each have three protuberances at the apex of a first-formed basal portion. Ingold and Cox (1957) suggest that it may become necessary to segregate *H. stellatus* and *H. longibrachiatus* from *H. aquaticus*. This author agrees that such a segregation may well prove necessary after further study of all the species involved, and points out again that the assignment of the fungus described herein to the genus *Heliscus* is tentative. It appears now, on the basis of their comparative morphology, that if and when a new genus is erected to contain *H. longibrachiatus* and *H. stellatus*, then *H. tentaculus* would fit well in that same genus.

Recently Ingold (1958) observed a hyphomycetous fungus growing on submerged leaves in streams in Uganda and Southern Rhodesia. His figures 3E and 3F depict spores very similar to those produced by the fungus described herein. Ingold stated that he was "almost satisfied" that the spores of his fungus were produced on phialides, and that if this were so, the fungus would be a member of the genus *Heliscus*. It is possible that we are dealing with the same species.

H. tentaculus may be separated readily from *H. aquaticus*. The spores

of the latter are multicellular and each spore has three short, blunt protuberances in contrast to the long slender branches of the spores of *H. tentaculus*. The two species differ also in that no sporodochium has been observed for *H. tentaculus*. The present species is distinct from *H. longibrachiatus* in that the spores of *H. tentaculus* are always at least twice as long as those of *H. longibrachiatus*, and in the latter species a single phialide terminates the simple, unbranched sporophore. In *H. tentaculus* the sporophore is often branched, and each branch may be terminated by more than one phialide (fig. 8). Differences between *H. tentaculus* and *H. stellatus* are likewise readily apparent. The three branches of the spore in the latter species are short conical, and of about the same dimensions as the basal portion of the spore, whereas the branches of the spores of *H. tentaculus* are slender filiform structures much shorter than the basal portion of the spore of which they are parts.

The proposed specific epithet, *tentaculus*, was suggested by the tentacle-like appearance of the three divergent branches arising from the apex of the basal portion of the phialospore.

SUMMARY

Heliscus tentaculus, an aquatic Hyphomycete found on submerged, decaying leaves of *Platanus occidentalis* and *Fagus grandifolia* in Montgomery County, Virginia, is described. The fungus is characterized by a branched, septate mycelium and hyaline sporophores which may branch at the apex to form one or more groups of phialides. These produce in basipetal succession hyaline, unicellular, elongately clavate phialospores which bear three slender, tentacle-like branches at the swollen apex. The taxonomic status of this fungus and related species relative to the validity of the generic assignments is discussed.

ACKNOWLEDGMENTS

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LITERATURE CITED

- Ingold, C. T. 1942. Aquatic hyphomycetes of decaying alder leaves. *Trans. Brit. Mycol. Soc.* 25 (1):339-417.
- 1958. Aquatic hyphomycetes from Uganda and Rhodesia. *Trans. Brit. Mycol. Soc.*, 41 (1): 109-114.

- and V. J. Cox. 1957 *Heliscus stellatus* n. sj., an aquatic hyphomycete. *Trans. Brit. Mycol. Soc.*, 40 (1): 155-158.
- Saccardo, P. A., 1880. Conspectus generum fungorum Italiae inferiorum. *Michelia* II: 1-38.
- Umphlett, C. J. 1957. Aquatic Hyphomycetes, including *Heliscus tentaculus*, n. sp., on decaying angiosperm materials. M. S. Thesis, Virginia Polytechnic Institute, Unpublished.

SKIN AND HAIR FOLLICLE DEVELOPMENT IN DAIRY GOATS

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With the exception of the improved domestic wool sheep, seasonal shedding is considered to be a universal phenomenon in fur-and wool-bearing animals. The object of the present study was to find out whether essential differences in the nature of histogenesis and further development exist between the skin and hair follicles of dairy goats and Karakul sheep, and whether these observations would contribute to the appreciation of some basic processes involved, culminating in production of the various wools, and possibly also of mohair.

Descriptions of the pre- and post-natal development of hair follicles in animals related to goats have been confined to a few breeds of wool sheep. The bibliography and the subject itself have been admirably reviewed and presented by Carter (1955). Hence only publications pertinent to this study will be referred to here.

While dairy goats undergo a well pronounced seasonal shedding, the situation is not so definite in the Karakul sheep. Lepeshchinskaya (1952) speaks of clear cut shedding and seasonal changes in the Karakul in the U. S. S. R. and Tanzer (1928) describes shedding in the Karakul in Germany as a process spread over a considerable period of time, involving, therefore, simultaneously relatively few follicles per unit of skin. No mass shedding was evident whatever in the Karakul flock kept from 1928 to 1951 at Beltsville, Maryland.

Shedding and non-shedding are evidently heritable characters. However, in view of the findings of Lepeshchinskaya (1952) that a definite shedding season exists in the Karakul and because of its absence in the Beltsville flock, environmental factors must be considered as being possibly instrumental in causing it in some sheep like the Karakul. Goats seemed well suited for the present study as they are closely related to sheep. Both are members of the Bovidae. The generic differences between sheep and goats, such as the presence of glands in the fore and hind feet of sheep, differences in skull form, in the direction of spiralling of horns, etc., are unimportant as compared to similarities of structure, general physiology of these animals, and the duration of

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fetal development. Gestation in both sheep and goats is about 150 days, which makes a chronologic comparison of their skins a particularly suitable one.

Material. Samples collected for the present studies were obtained from the skin of the mid-dorsum and mid-venter of the common American and Toggenburg goats from the Beltsville flock of the Agricultural Research Center, United States Department of Agriculture at Beltsville, Maryland, in the course of the years 1949 to 1956.

Twenty-two fetuses ranging in age from 39 to 145 days of uterine life, 12 kids, 1 to 210 days old, and 16 goats, 1 to 9 years of age, were used. Of the fetuses, 14 were of the common American breed, 7 were pure Toggenburg, and 1 carried 75% Toggenburg heredity. Among the postnatal samples — 20 were common American, 7 Toggenburg, and 1 carried 50% Toggenburg heredity. Both sexes, including two 3-year wethers were represented. No developmental differences connected with breed or sex were noted.

The Karakul material consisted of skin samples taken from the dorsum and venter of a strain which originated also from the Beltsville flock. These Karakul samples were collected during the years 1949-1951 and were partially described by Margolena (1954).

Methods. Mid-dorsal and mid-ventral skin samples, cut out in rectangles about 1 to 2 inches or smaller, depending on the size of the animal, were collected immediately upon slaughter. The hair was sheared or clipped with a pair of small animal clippers from the area chosen, after which both the skin and the razor were sterilized in 70% alcohol prior to taking the sample. The same procedure was used for younger fetuses, with the exception that, of course, the naked ones needed no shearing. The skin was next flattened out on file card stock of appropriate size and transferred to Bouin's solution for fixation. After 24 or more hours as required for older specimens, the skins were dehydrated with the addition of butyl alcohol to the ascending series of ethyl alcohols, and finally pure butyl alcohol was used as an intermediate medium prior to infiltration in tissue mat. Sections were cut at 8 microns and heavier, where needed.

For staining the following procedures were used: Hematoxylin, Phloxine, Orange G (Margolena, 1933); Orcein, Mallory 11, Orange G (Margolena, 1950) and Feulgen's chromatin reaction counterstained with picric acid and fast green.

Measurements were carried out by means of ocular micrometers. The epidermis was measured at a magnification of 230 with a Spencer binocular; the dermis and depth of follicular penetration were measured at a magnification of 40 with a Reichert Zetopan; for the diameters of fol-

licular bulbs a magnification of 80 was used with the Reichert microscope. The averages arrived at were based on figures from no less than 10 measurements taken usually from material on several slides.

The ratios between the secondary and the primary follicles were obtained by counting follicles contained in 236 bundles. This included over 700 primary and over 270 secondary follicles. Skins of 5 common American and 4 Toggenburg goats were used for the above counts.

DISCUSSION AND RESULTS

In goats, as in wool-bearing animals, and this is probably the case for mammals in general, the hair follicles develop at certain stages of their life history. The follicles develop in a definite sequence, and those appearing earliest are referred to as primary. In sheep and goats they are characterized by the presence of three accessory structures: the sebaceous and sudoriferous glands and the hair muscle. The secondary, or later developing follicles, show no sudoriferous gland nor muscle, and may or may not possess a sebaceous gland. In both Karakul sheep and the common American and Toggenburg goat, the larger primary follicles remain distinguishable throughout their lives. The fibers may also be distinguishable because of their larger diameter.

The appearance and differentiation of follicles is dependent on the physiologic and histologic preparedness of the skin to initiate and support such development and growth. Mature fully differentiated skins are incapable of recapitulating the process, thus the new follicles can only be initiated in regions where for one reason or another, e.g. wound healing, new skin is developing and undergoing stages corresponding to those found in fetal or very young animals (unpublished data on Merino and Hampshire sheep and Toggenburg goats at Beltsville, Maryland).

Development of the hair follicles in mid-dorsal and mid-ventral regions of the goat skin. The primary follicles develop in groups of three, hence the expression "trio". The anlage of the first primary follicle, that is the future central follicle, appears between the 65th and 70th day; this is soon followed by 2 lateral follicles, which are also primary follicles, but of slightly later initiation, thus establishing the trio group membership between the 75th and 85th day.

In about three weeks after the development of the primary follicular generation the first early anlagen of the secondary follicles begin to appear, which is upward of 90 days. Unlike the situation in the Karakul sheep, where initiation of the secondaries is practically confined to a few weeks (approximately 90 to 105 days of intrauterine life, Margolena, 1954), the initiation of the secondary follicles in goats is extended through fetal and early postnatal life, Chart 1.

SEQUENCE IN FOLLICULAR DEVELOPMENT in Fetal Skins

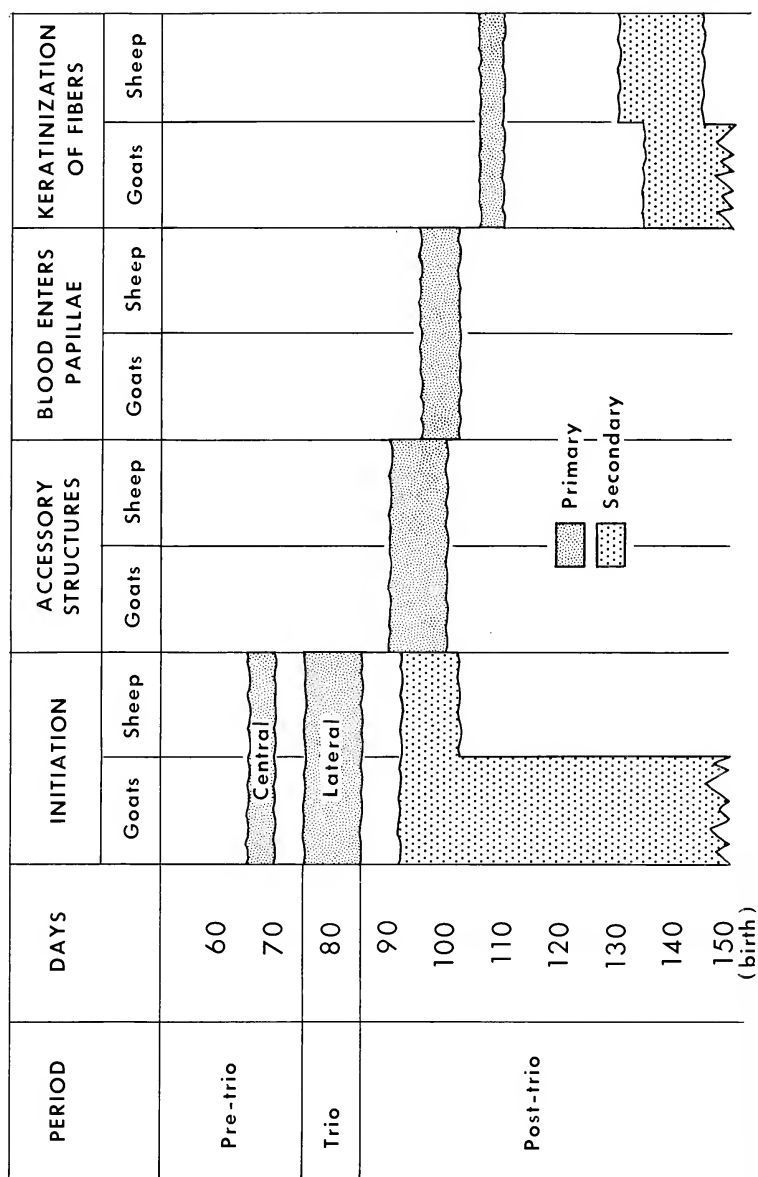


Chart 1. Sequence of events in the development of primary and secondary follicles in fetal skins of dairy goats and Karakul sheep.

Development of later secondary follicles in lambs several weeks old is apparently a phenomenon which takes place not only in Merino, but also in some of the British Mountain sheep, Ryder (1957).

Differentiation and maturation of the primary follicles. Follicular accessory structures develop in goats from about the 90th to 100th day of uterine life, which is similar to the period when they develop in Karakul sheep fetuses. Sudoriferous glands develop a few days ahead of the sebaceous glands which is according to the general pattern of hair follicle differentiation.

The direct blood supply, that is the actual entry of capillaries in the follicular papilla, takes place at a time when the papilla is well established during the 95th to 105th day. Chart 1.

In his comprehensive presentation of the blood supply to wool follicles, Ryder (1955) writes that in the 100 day Romney fetus, blood vessels have not yet entered the dermal papilla. It appears, therefore, that both in the Karakul and goat fetuses the blood capillaries may penetrate the papilla slightly earlier than is the case with Romney sheep. Nevertheless, in both breeds of sheep and in goats, hairs are already definitely growing in the primary follicles at about 110 days of uterine life.

The penetration of the blood capillaries in the follicles of Karakul sheep and goats seems to be synchronized with the differentiation of the outer epidermal root sheath. This sheath becomes delineated from other epidermal formations particularly by a conspicuous row of cells with nuclei which have migrated away from the side closest to the connective tissue elements, and are disposed on the side closest to the follicular axis. A similar temporary transformation of epidermal cells was first presented by Segall, (1918) in his beautifully and clearly illustrated work on the guinea pig follicles, and later by Spottel and Tanzer in Merino fetuses in 1923.

The maturation of the follicles, beginning with the keratinization of the cells forming the sheath about the growing hair, and referred to as the hair cone, follows the direct blood supply within about a week. Growth and further development of the follicles and hair from here on takes approximately 10 days and the primary hair pierces the skin before or at 120 days of uterine life. All this is similar to the development as found also in the Karakul sheep.

The relative increase in size of primary follicles (phenomena associated with shedding excluded) can be judged by the depth of follicular penetration in the skin as shown in figures 1, 2 and 3 and Table 1. The straight hair of goats develop in follicles that are more or less slanting throughout their pre- and post-natal histories, very much like

TABLE 1. AVERAGE THICKNESS OF DERMIS AND MAXIMUM DEPTH OF FOLLICULAR PENETRATION OF PRIMARY FOLLICLES IN DERMIS OF FETAL, KID AND GOAT SKIN.

GOAT FETAL SKIN				
Days	Dermis mid-dorsum (mm)	Follicular penetration mid-dorsum (mm)	Dermis mid-venter (mm)	Follicular penetration mid-venter (mm)
75-80	0.30	0.10	0.25	0.10
81	0.30	0.10	0.45	0.10
88	0.50	0.20	0.60	0.20
88	0.60	0.15	0.60	0.15
92	0.60	0.30	0.50	—
103*	0.60	0.15	0.50	0.15
112	0.90	0.50	1.0	0.50
118	1.30	0.80	—	0.70
120	1.45	0.85	—	1.0
130	1.10	0.80	1.10	0.70
134	1.45	0.85	—	—
143	1.60	0.80	2.20	1.0
145	1.10	0.70	1.5	0.80
KID SKIN				
1	0.90	0.60	—	—
3	1.20	0.55	1.10	0.60
5	1.75	0.90	2.00	0.90
10	1.80	1.10	1.30	0.70
30	1.85	1.25	1.20	0.65
120	1.80	1.10	2.00	0.90
GOAT'S SKIN				
Years and months				
1 yr.	1.90	0.80	1.35	0.70
1 yr. 4 months	1.65	0.90	1.30	0.80
2 yr. 4 months	2.75	1.10	2.55	0.85
3 yr.	2.40	1.45	2.00	0.90
3 yr. 8½ months	4.40	2.45	3.40	1.30
3 yr. 9 months	3.10	1.45	2.45	1.45
5 yr.	3.55	1.80	1.95	0.80
7 yr.	3.85	2.20	2.40	1.10
8 yr.	3.30	1.45	1.65	0.70
9 yr.	3.30	1.45	—	—

*These skins were from fetal twins, supposedly 103 days old, and born from a doe which gave a positive Johne's reaction. They showed a considerable retardation of follicular development, and were rather small if their age actually corresponded to our records.

TABLE 2. AVERAGE THICKNESS OF EPIDERMIS OF FETAL, KID AND GOAT SKIN.

Days	Goat Fetal Skin		Goat Skin	
	Mid-dorsum μ	Mid-venter μ	Years and months Mid-dorsum μ	Mid-venter μ
39	6	6	1	16
50	14	14	1 yr. 4 mo.	17
75-80	24	24	2 yr. 4 mo.	18
81	24	28	2 yr. 6 mo.	19
88	28	24	3 yr.	22
92	25	25	3 yr. 8½ mo.	27
103	26	25	3 yr. 9 mo.	16
112	21	18	5 yr.	21
120	17	14	6 yr.	13
130	16	17	7 yr.	23
143	17	16	8 yr.	16
145	16	16	9 yr.	30
<hr/>				
	Kid Skin			
1	16	16		
3	16	16		
5	16	16		
10	16	15		
30	18	16		
120	30	16		
210	21	17		

those of Karakul sheep and unlike the twisted and curled follicles of the Merino sheep. There is, however, a surprisingly straight phase exhibited by both goat and Karakul dorsal follicles at about birth and for some 10 days after. Whether that period during which the primary follicles are disposed at a right angle in relation to the surface of the skin is caused by the tension associated with accelerated growth during the first postnatal days is a question that remains to be answered.

Maturation and keratinization of the secondary follicles. While keratinization is close to completion a few days before birth in the Karakul,

at about 130 days of prenatal life, this is not the case with goats, where maturation is spread out from about 135 days of fetal life to the first postnatal month. In this respect, goats are more like fine wool sheep (*e. g.* the Merino) than the Karakul sheep.

Another possible difference in the development of the secondary follicles of dairy goats is the incidence of sebaceous glands. Sparse and uneven sebaceous glands will be encountered in the early development in goats, while they are practically absent in the Karakul sheep.

The blood supply in the papillae of the small secondary follicles in goats is not only less pronounced as compared to that of the primary ones, but appears even somewhat uncertain. The dermal papillae may have difficulty in getting themselves established within a space that is hardly large enough to house the connective tissue cells forming it, not to speak of the area necessary to accomodate two capillary loops. The chronologic development of secondary fibers is shown in Chart 1.

In view of the more flexible and variable nature of the secondary follicles, it is suggested that attempts to improve the quality of wool or other fibers, particular attention should also be devoted towards factors which might influence the initiation and maturation of the above follicles.

Maturation and growth of the bulbs of the primary follicles. Measurements of the diameters of the bulbs of pre- and post-natal primary follicles of goats and Karakul sheep indicate that the bulbs of goats attain their mature dimensions later in development than those of the Karakul. Thus the diameters in sheep are well within the range of that found in mature animals (110-135 microns) beginning with fetuses 4 months old, while the bulbs of goats do not reach their full dimensions (90 to 115 microns), until about 10 days after birth.

Tolmakova (1956) found that bulbs of the primary follicles of "Elite" Karakul newborn lambs measured 117 to 129 microns at Sovkhoz "Mura-bek", U. S. S. R., while those of another good variety, but with a fur less dense than in the "Elite" and sampled at same age were 130 to 145 microns. Tolmakova's values confirm our findings that Karakuls have comparatively larger bulbs than goats.

Skin development and differentiation. In goat skins, just as in Karakul skins, and at variance with that of the Merino, a progressive thickening of the dorsal corium takes place as the kid, or the lamb develops into a mature and eventually older animal, figures 2 and 3.

The measurements presented may not quite give the whole story of the thickness of the skin, assuming that it may vary according to sea-

GOAT: FETAL

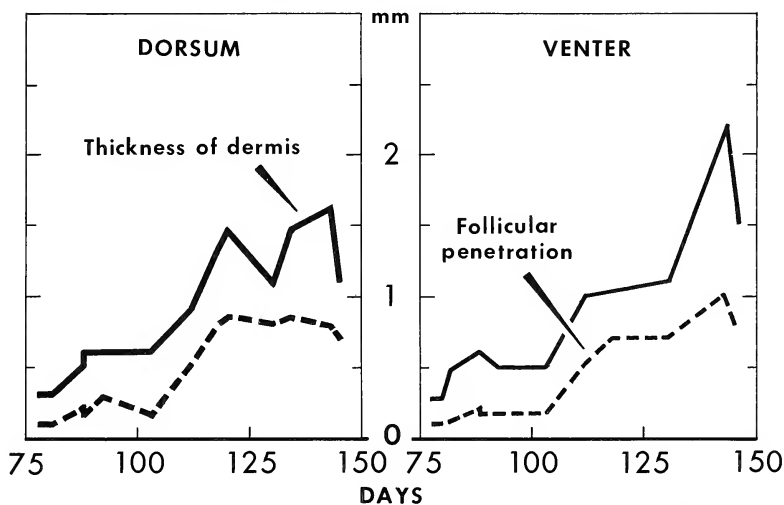


Fig. 1. Average thickness of dermis and maximum depth of follicular penetration of primary follicles in dermis of goat fetal skin.

KID

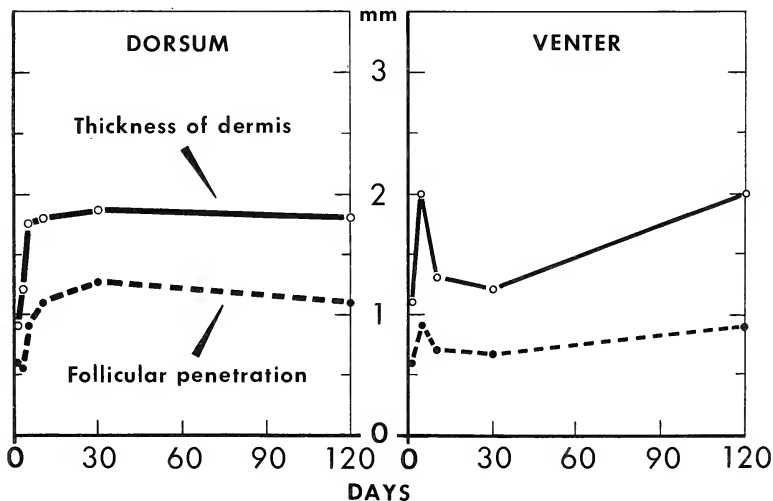


Fig. 2. Average thickness of dermis and maximum depth of follicular penetration of primary follicles in dermis of kid skin.

GOAT: POSTNATAL

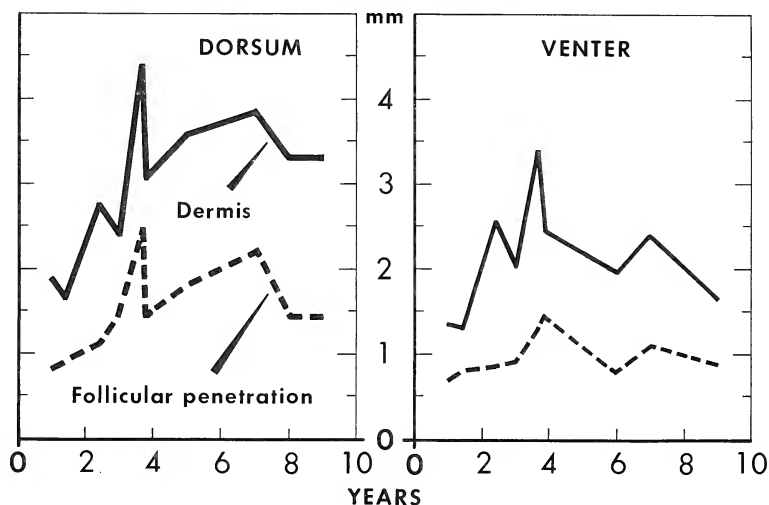


Fig. 3. Average thickness of dermis and maximum depth of follicular penetration of primary follicles in dermis of goat skin.

EPIDERMIS: FETAL AND KID

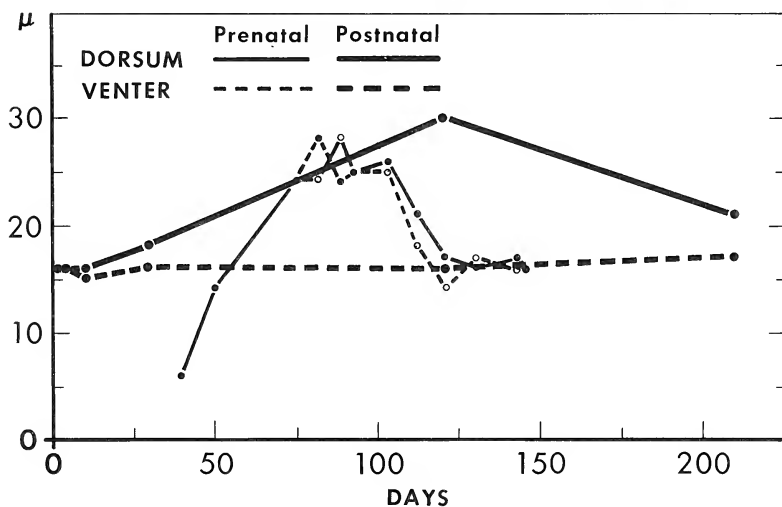


Fig. 4. Average thickness of epidermis of goat fetal skin and of kid skin.

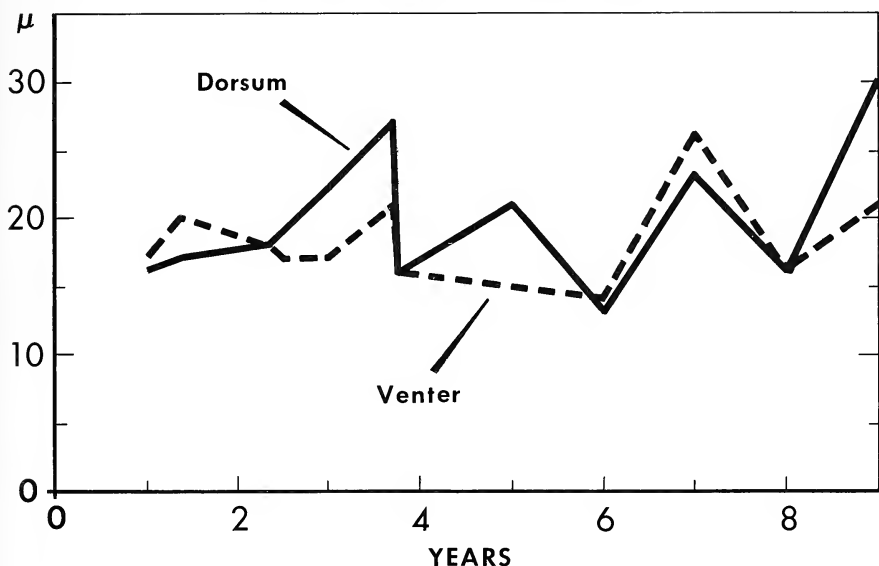
EPIDERMIS: GOAT

Fig. 5. Average thickness of epidermis of goat skin.

son. With the exception of two December specimens (one 2 years 4 months, and the other 3 years 9 months of age), mature skins available were from animals slaughtered during the second or third week of October. None was representative of early or mid-summer, and only three were late summer skins (collected in September); of these one was a one-year old goat, and two were kids, 1 and 10 days old.

The general tendency, however, of mature and older animals to show heavier skins accompanied by a greater depth of follicular penetration as compared to younger ones, has been also found in the Karakul by recent workers — Tolmakova (1956), Diomidova (1957), and the author (1954).

Unlike the skins of the Karakuls, where shedding and resting hair follicles are rare, some shedding or resting hair as well as new growing ones were noted in goat specimens taken in January, March, September, October, November, December and January. Some early January samples contained more new growing hair than mature primary follicles. These samples are not included in our measurements because too few animals were available.

Shedding hairs in goats appears to be of the usual "brush" type. The stages leading to and shedding of the primary follicles during the

colder months is a phenomenon hardly noticeable on the surface, especially as compared to the conspicuous shedding involving the underhair (secondary follicles) in early and mid-summer.

Measurements of the dorsal dermids of mature animals varied from 3 to near 4 millimeters. The heaviest, 4.4 millimeters, happened to be that of a Toggenburg male almost 4 years old. The softer and thinner ventral skins showed less uniformity as a whole. Nevertheless, the same male which had a heavier dermis in the dorsal region, measured also a heavier one in the ventral region, figure 3, table 1.

The epidermis of the goat's skin. The epidermis remains a thin layer throughout pre-and postnatal life. Disregarding the irregularly present periderm of certain fetal stages, it is barely 6 microns wide prior to follicular initiation. The germinal layer of the epidermis is 20-28 microns thick during the height of its activity, that is during that period when the anlagen of the primary and earlier secondary follicles are being initiated, figures 4 and 5, and table 2. It is interesting to find that the mitotic counts in the cells of the fetal epidermis of the Karakul are highest at that same period, that is between about the 65 and 95 days of uterine life. (Margolena and Dolnick, 1953)

Once the anlagen of the primary and earlier secondary follicles in goats are established, the diameter of the germinal layer of the epidermis returns to that found just prior to their initiation. In fetuses 4 months old it is about 16 microns wide. In mature animals the germinal layer varies around 25 microns. The differences between the diameters of the dorsal and ventral epidermis of goat skins are quite comparable to variations within any spot in the same region.

The same general trend is described by Diomidova (1957). However, the value of 8 to 9 microns, as given by her for the germinal layer of the epidermis of the skin of Karakul fetuses ranging in age from 4 months to the time of birth seems low.

Differentiation of the dermis of goat skin. The differentiation of the corium is directly related to processes taking place in the epidermis and conditions the development of the follicles. The appearance and behavior of melanocytes will be dealt with elsewhere. At the time the first follicular anlagen are being formed there is no differentiation of the mesenchymal cells except for a formation of a layer denser than the rest of the embryonal tissue and with elements disposed parallel to the surface.

Blood capillaries are found in the proximity of follicular anlagen. The above developments appear to proceed almost simultaneously. Capillaries and blood vessels in the skin of goats become particularly conspicuous during the trio stage. Here the capillaries may appear to delineate the

trio group, similar to the way that the collagenic fibers will almost appear to fence in portions of follicles.

Gradually, while the trio stage progresses, collagenic fibers make their appearance. Their differentiation is more pronounced in the lower regions of the dermis, where they are found in heavier bundles,

Fat cells appear at practically the same time, that is upwards of the 80th day of fetal life. They appear in the deeper reticular region in the vicinity of blood vessels or capillaries in units of from 1 to 5 cells, and increase in numbers until fat cells form longish islands of fairly loose discontinuous adipose tissue amidst the areolar mesh. The groups of fat cells lie parallel to the underlying skin muscle. In goats the accelerated period of fat cell development is apparently terminated in fetuses about 4 months old.

Fat cells in animals here examined were found under the limits of follicular penetration, not between the follicles themselves, as is the case during certain stages of fetal follicular development of the softer skins of ranch mink, Dolnick (1955).

Elastic fibers appear apparently later than the collagenic ones. They are, however, present about the time the primary follicles begin to keratinize. This refers to elastic fibers as constituents of the network as such, for they are, of course, developed at much earlier stages in the walls of the vessels of the immature fetal skins.

Follicular ratio. The average ratio between the secondary and primary follicles of dairy goats was found to be 3.97, with a range of 9 to 14 per bundle. It seems interesting to note that even this approximate figure is close to that found in the Beltsville Karakul flock, and perhaps not essentially different from some of the British Mountain breeds, Ryder (1957).

SUMMARY

A description of the development and differentiation of skin and hair follicles of the common American and Toggenburg goats from fetal stages through maturity is presented and compared with that of the Karakul sheep. Measurements of the fetal and postnatal skins, depth of follicular penetration, and ratios between the secondary and primary follicles are included.

Despite the fact that the dairy goats observed undergo regular seasonal shedding and belong in a different genus (*Capra*), than the non-shedding Karakuls of the Beltsville, Maryland flock, (*Ovis*), the initiation and maturation of the secondary follicles in goats appear closer chron-

ologically to fine wool sheep than to the Karakul. However, differences in size between the primary and secondary follicles are more pronounced in goats than in the Karakul and still more than in the fine wool sheep.

The general sequence of events in the development of the skin components and of the primary follicles in the above goats and sheep proceed too closely to be due to chance. However, differences in the time and span of production, maturation and morphologic detail of the secondary follicles are more variable in goats than in the Karakul.

LITERATURE CITED

- Carter, H. B. 1955. The hair follicle group in sheep. *Animal Breeding Abstracts*. 23:101.
- Diomidova, N. A. 1957. Individual character in the development of the skin and hair follicles of Karakul lambs. *Karakulevodstvo i Zverovodstvo*. 10:39. (In Russian)
- Dolnick, Ethel H. 1955. Histogenesis of hair in the mink. Doctoral Dissertation, George Washington University. (Unpublished) 83 pp.
- Lepeshchinskaya, E. M. 1952. Seasonal changes of the skin of mammalian animals. *Jour. Zool.* 31:434. (In Russian)
- Margolena, Lubow A. 1933. Phloxine with Orange G as a differential counterstain. *Stain Technology*. 8:157.
- Margolena, Lubow A. 1950. A differential staining method for elastic fibers, collagenic fibers and keratin. *Stain Technology*. 26:119.
- Margolena, Lubow A. and Ethel H. Dolnick. 1953. Cell division in the epidermis of the fetuses and young lambs of Karakul sheep. *Virginia Jour. Science*. 4: Abstracts.
- Margolena, Lubow A. 1954. Sequence and growth of primary and secondary fiber follicles in Karakul sheep. *Jour. An. Sci.* 13:765.
- Ryder, M. L. 1955. The blood supply to the wool follicle. *Proc. Intern. Wool Text. Res. Conference*, Australia, F63.
- Ryder, M. L. 1957. A survey of the follicle population in a range of British breeds of sheep. *J. Agr. Sc.* 49:275.
- Segall, A. 1918. Wechsel der Haare beim Meerschweinchen, Cavia cobaya. *Arch. Mike. Anat.* 91:218.
- Spottel, Walter and Tanzer, Ernst. 1923. Rassenanalytische Untersuch-

ungen an Schafen unter besonderer Berücksichtigung von Haut und Haar. *Arch. Naturgesch.* 89:1.

Tanzer, Ernst. 1928. Haut und Haar beim Karakulschaf im rassenanalytischen Vergleich. *Kuhn Archiv.* 18:151.

Toľmakova, G. M. 1956. Age changes of the skin and hair cover of Karakul lambs in connection with the quality of the pelt. *Karakulevodstvo i Zverovodstvo.* 9:25 (In Russian)

News And Notes

(Editor's Note). News contributions should be sent to the person whose name appears at the end of the appropriate sections.)

MESSAGE FROM THE PRESIDENT

The 1959 meeting of the Virginia Academy of Science will be held at the University of Virginia, May 7-9 inclusive. It is our earnest hope that as many as possible will attend, and will also contribute to the success of the meeting by presenting papers. It is fitting that in this time of such great interest in science that the Academy should meet at an institution founded by Thomas Jefferson, one of the first great American Scientists.

Your officers look forward to a stimulating meeting as we gather in the hallowed halls of the University of Virginia. Although the presentation of a paper at the annual meeting of the Academy may not add anything to the professional reputation of a seasoned investigator, nevertheless, the fact that he, or she, does present a paper is of great inspirational value to those who are starting on their scientific careers. May we look forward to having your advice and guidance, not only at the various scientific sessions, but also at the Academy Conference and business meeting?

The J. Shelton Horsley Research Award is given each year for a "highly meritorious" paper presented at the Academy's annual meeting. Details of this award will be sent you by the secretaries of the various sections.

We are very fortunate in having Mr. S. I. Gale, Fellow of the Royal Astronomical Society of London, and a member of the Development and Research Staff of the Bound Brook Plant of American Cyanamid Company as our guest speaker for the Friday night meeting. His topic will be "Chemistry on a Cosmic Scale."

One of the major functions of the Academy is to encourage and develop scientific interest among the youth of the State. To this the Senior Academy is dedicated. It is so easy to forget one's obligation to youth and to assume that someone else will do what should be done. May I urge that when the secretaries of the various sections ask you to appear on the program you will give the request serious consideration. May I also urge as many as possible of the senior scientists to visit the exhibits of the Junior Academy. I am sure the juniors will appreciate it and that you will not be disappointed by the reception that you will be given. Please

do not forget the commercial exhibits where you will see the latest in scientific equipment and in books.

The local Committee on Arrangements, under the able direction of Dr. S. P. Marony, has its plans for the meeting well organized and nearly complete. I am sure you will all be pleased with the facilities and other arrangements which are being made not only for the scientific part of the program but also for your pleasure and comfort.

— J. C. Forbes, *President*

RESEARCH COMMITTEE NOTICE

The Research Committee of the Virginia Academy of Science invites members of the Academy to submit papers in the 1958 competition for the J. Shelton Horsley Research Prize. Papers should be submitted to Section Secretaries so that they may be forwarded to the Research Committee by April 15, 1958. Papers should be submitted in triplicate and to be eligible (1) should contain original research, (2) the author must be a member of the Academy, (3) the paper must be presented at the May, 1958, meeting, and (4), although the paper may be either published or unpublished, publication must not have been prior to May of the preceding year (reprints may be submitted). It is expected that the winner's paper, or a revision of it, will be made available for publication in the VIRGINIA JOURNAL OF SCIENCE. No person will be awarded the prize more than once. The J. Shelton Horsley Research Award is made annually and consists of recognition for meritorious research and a cash prize of \$100.00.

The Research Committee also has some funds available for small research grants and applications for grants will be welcomed. The 1958-59 Committee has prepared a list of information required in an application for a grant, and this can be obtained by prospective applicants by writing to the Chairman, Ralph A. Bradley, Department of Statistics, Virginia Polytechnic Institute, Blacksburg, Virginia.

— R. A. Bradley, *Chairman*

AGRICULTURAL SCIENCES

Russell G. Louis has returned to his position as associate professor of Industrial Arts Education, Department of Vocational Education, Virginia Polytechnic Institute, after serving as Educationist, U. S. Mission to Haiti.

Kenneth E. Dawson, who served as assistant professor in Mr. Louis' absence is now enrolled at the University of Maryland as a candidate for a doctor's degree.

Dr. W. G. Evans resigned August 1, as assistant professor of Entomology at Virginia Polytechnic Institute to accept a position at the University of Alberta, Canada. Jack Lynn Bishop, with B.S. and M.S. degrees from Kansas State and nearing completion of work on his Ph.D has been appointed assistant professor of Entomology.

Littleton W. Johnson with B. S. degree has been appointed assistant professor of Food Technology to serve as extension specialist and assistant with research in fruit and vegetable processing in the Department of Horticulture at Virginia Polytechnic Institute. He replaced Roy Moser who resigned to accept a position at Oregon State.

Mr. Roy Russell has been appointed assistant professor in the Department of Agricultural Economics, Virginia Polytechnic Institute to work in Livestock Extension Marketing. Mr. Russell holds a B.S. degree from Alabama Polytechnic Institute and has completed requirements for his M.S. from the same school. He comes to the V. P. I. directly from graduate school and is a native of Alabama. The position being filled by Mr. Russell was formerly held by Mr. Shirley Carter who resigned to do graduate work at North Carolina State.

Mr. Albert J. Ortego has been appointed assistant professor in the Department of Agricultural Economics, Virginia Polytechnic Institute to work in Dairy Marketing Extension. Mr. Ortego holds the B.S. degree from Southern Louisiana Institute and the M.S. degree from Louisiana State University and is a native of Louisiana. The position he fills was held by Dr. Carl T. Arnold who transferred to research and teaching January 1, 1958.

A grant of \$344,005 for health related research facilities has been approved for the Virginia Polytechnic Institute by the National Institute of Health.

This money will be used in providing research facilities in the biochemistry and nutrition laboratory for which the 1958 General Assembly appropriated \$490,000. The grant of \$344,005 was made on a matching basis.

The grant will be used to strengthen the research being conducted at Virginia Polytechnic Institute in the health related sciences. These include the evaluation of the use of such chemicals as pesticides, herbicides, and fungicides on crops and animals as they influence human health.

Other matters upon which research will be conducted include the determination of nutritional requirements of pre-adolescent children; use of antibiotics in disease control and as growth stimulants of animals and

poultry; and the impact of food processing on the wholesomeness and nutrient values with emphasis on new methods of sterilization.

The grant combined with the state appropriation will provide a three story building and research facilities in bio-chemistry, micro-biology, and nutrition. The building and its facilities will be directed by the bio-chemistry and nutrition department of which Dr. R. W. Engel is head.

— Carl W. Allen, *Virginia Polytechnic Institute*

BACTERIOLOGY

Dr. E. C. Nelson of the Medical College of Virginia, Richmond, Virginia, attended the 6th International Congress for Tropical Medicine and Malaria in Lisbon, September 5 to 13.

Dr. P. A. Hansen participated in the Symposium on: "Exchange of genetic materials. Mechanisms and consequences" held at Cold Spring Harbor, Long Island, June 3 to 11.

BIOLOGY

Dr. Huseyin Gokcora, Associate Professor, University of Ankara, Turkey and also Dr. Josip Gotlin, Associate Professor, Zagreb University, Yugoslavia worked with Professor W. Ralph Singleton—learning new techniques and methods—at the corn breeding radiation laboratory at The Blandy Experimental Farm during the summer of 1958. Both Dr. Gokcora and Dr. Gotlin were Fellows of the International Cooperation Administration.

Among foreign visitors to The Blandy Experimental Farm during the summer of 1958 were geneticists from Argentina, Australia, Japan, and Yugoslavia. In addition four students from Turkey and a group of 13 students from France studied work in progress at Blandy.

A number of members of the Northern Nut Growers Association from mid-western states visited The White Arboretum at Blandy Farm, enroute to their annual meeting at Beltsville, Maryland, on August 16 and 17, 1958. The heavily-fruited selected paw-paw trees (*Asimina triloba*) were among the chief objects of interest to the group.

At Bridgewater College Dr. Frances E. Silliman has returned to the Biology Department after completing doctoral studies and receiving her degree at the University of North Carolina, where she also assisted in the Department of Botany. Professor Harry G. M. Jopson participated in the National Science Foundation Institute for College Teachers of Biology

held at Oregon State College, Corvallis, Oregon during the summer. Mrs. Elizabeth League Kyger has resigned her position in the department, but will continue to reside in Bridgewater.

Mr. Robert E. Merritt has returned to his position in the Longwood College Department of Biology after a year of graduate study at the University of Tennessee. Dr. J. M. Lodewijks who substituted for Mr. Merritt last session has returned to his home country, The Netherlands. His present address is Buizerdlaan 13, The Hague, Holland.

Mr. A. H. O'Bier, Jr., who last year assisted Dr. R. T. Brumfield, at Longwood, under a grant from the Atomic Energy Commission is pursuing graduate studies at Virginia Polytechnic Institute.

Dr. Paul J. Osborne of the Biology staff of Lynchburg College, spent the past summer at the Duke Marine Laboratory, Beaufort, North Carolina, working on the energy cycles of marine invertebrates, determining whether they fixed carbon dioxide, and if so, observing any phylogenetic similarities and differences. The work was done by means of radioactive tracers, coupled with paper chromatography. He worked with Dr. Carl Hammen, under the direction of Dr. Karl Wilbur. Dr. Osborne's work was made possible by a research grant from the American Physiological Society.

Dr. John G. Mahan, also of the Lynchburg College Biology staff, was a member of a team from that college which participated in the Danforth Foundation College Community Workshop, at Colorado Springs, Colorado for three weeks last summer. Twenty-eight colleges were represented in a consideration of the place of the small college in modern education.

At the University of Richmond Dr. Jack D. Burke has been awarded a grant from the Sigma Xi Research Fund for blood studies in the armadillo. Dr. William S. Woolcott, of the same institution, gave a course in animal ecology during the first term at the Mountain Lake Biological Station.

Dr. Harry L. Holloway has been promoted to Professor of Biology at Roanoke College. He has recently received grants-in-aid for the purchase of equipment, in connection with studies on the helminths of wild animals in Virginia, from the Sigma Xi-RESA Research Fund and from the Virginia Academy of Science.

Mr. William N. Garner was appointed Assistant Professor of Biology at Roanoke College in 1957. He received the B. S. degree in biology and chemistry from Bethany College and the M. A. degree in zoology and botany from Duke University.

Eta Eta Chapter, Tri-Beta Society, Roanoke College and the Roanoke Valley Bird Club are presenting a series of lectures by eminent naturalists (Audubon Screen Tours) on the campus during the session 1958-59. Allan Cruickshank spoke on October 21 on the topic "River of the Crying Bird"; Fran William Hall on December 3 lectured on "Puerto Rico, U. S. A."; and on April 18 Emerson Scott will discuss "Rocky Mountain Rambles".

The Mountain Lake Biological Station has recently been advised by the National Science Foundation that its grant of \$18,000 for three years has been renewed (1959-1961). This grant has made available funds for the establishment of Awards for research and study at the Station. Three types of awards are available: Post-Doctorates, for research; Pre-Doctorates, for supervised research; and Post-Graduates, for training in field or laboratory research techniques, thus permitting course work. Application blanks for these awards may be secured from the Director, Mountain Lake Biological Station, Department of Biology, University of Virginia, and must be submitted by April 1, 1959.

— Walter S. Flory, Jr., *Blandy Experiment Farm*

CHEMISTRY

Bridgewater College Chemistry Department is offering an upper-level undergraduate chemistry course in Advanced Organic Chemistry, taking up such topics as mechanisms of organic reactions, dyes, vitamins, steroids, alkaloids, etc. This course is being offered in the evenings, for the benefit of the chemical industry of this area.

Mary Kapp from Richmond Professional Institute was a summer employee in Research and Development at Philip Morris.

Dr. John H. Wise, Washington and Lee University, spent his fifth consecutive summer at Oak Ridge as a temporary employee of the Physics Division, Oak Ridge National Laboratory. In August, he was a participant in the Virginia Education Association Instructional Institute on "Science in the Secondary Schools" at Longwood College.

From Randolph-Macon Woman's College

A summer institute for high school teachers of science was held at the college from July 9 to August 21. Dr. Nan V. Thornton, Dr. Helen L. Whidden, and Miss Imogene B. Claiborne instructed in chemistry. The institute was sponsored by the National Science Foundation.

Mr. Forrest C. Hentz, Jr., has joined the Chemistry Department as

an instructor. He received his M.S. degree this summer from the University of North Carolina.

Dr. Nan V. Thornton attended the meetings of the American Chemical Society in Chicago in early September. She was also a participant in the Institute of the Virginia Educational Association at Longwood College, August 21-23.

Dr. Helen L. Whidden continued her work as technical adviser to the Chemistry Section of the Babcock and Wilcox Company this summer on a full-time basis. During the school year, she works part-time in the same position.

Dr. Laura Bliss attended the Fourth International Congress of Biochemistry in Vienna in September.

From the Virginia Polytechnic Institute:

William L. McPherson has been promoted from assistant professor to associate professor and also directs the work of the Radiochemistry Laboratory.

Dr. Alexej B. Borkovec joined the staff of the Chemistry Department in September as an assistant professor. He was previously employed by the Texas Division of the Dow Chemical Company.

Dr. Frank A. Vingiello taught in the first summer session at Duke University in North Carolina.

Dr. and Mrs. J. W. Watson attended the meeting of the American Chemical Society in Chicago in September.

Robert C. Krug and James A. Rigney presented a paper at the Chicago meeting entitled, "Unsaturated Cyclic Sulfines IV: Isomeric 2-Methyldihydrothiophene 1, 1-Dioxides."

Professor W. L. McPherson attended the Second Conference on Analytical Chemistry in Nuclear Reactor Technology sponsored by the Oak Ridge National Laboratory held on September 29, 30, and October 1, at Gatlinburg, Tennessee.

Dr. Luther K. Brice and Professor William L. McPherson were responsible for the Physical Science portion of the Virginia Polytechnic Institute Virginia State Fair Exhibit shown in Richmond, September, 1958.

Mr. N. B. Lorette, a Research Specialist from the Organic Basic Research Laboratory of the Dow Chemical Company, Freeport, Texas Division, and Mr. John Moore, Assistant Director of Research, Organic Chemistry Section, Dow Chemical Company, were visitors on our campus Octo-

ber 15 and 16. Mr. Lorette spoke before the local Chapter of Phi Lambda Upsilon on the Preparation of Ketals.

Dr. J. W. Watson retired as Head of the Chemistry Department on September 1 and the position is now filled by Dr. Robert C. Krug.

Mr. Clifton Wilson and Mr. John Sheridan joined the staff of the Chemistry Department as teaching assistants in September.

Dr. Robert C. Krug, Councilor representing the Virginia Polytechnic Institute, attended the Oak Ridge Institute of Nuclear Studies Council Meeting in Oak Ridge, Tennessee, October 21.

— M. A. Kise, *Virginia Smelting Company*

ENGINEERING

Dean Lawrence R. Quarles of the University of Virginia School of Engineering has announced the appointment of Professor Charles N. Gaylord of the Civil Engineering Department as Assistant Dean of the School of Engineering. Dean Quarles represented the University of Virginia on a NROTC cruise to Europe for two months from June to August. Professor Gaylord attended the annual meeting of the American Society for Engineering Education in Berkeley, California in June. In August Dean Quarles attended the Virginia Education Association Conference of Science Teachers in the capacity of consultant in physics. In October he represented the University of Virginia at the Atlanta meeting of the Regional Advisory Council on Nuclear Energy.

Professor Orville R. Harris of the Electrical Engineering Department of the University of Virginia was elected Secretary-Treasurer of the Virginia Section of the Institute of Radio Engineers. Professor R. E. L. Gildea of the Civil Engineering Department of the University was elected to membership in the American Academy of Sanitary Engineers in recognition of his high standing and long experience in this field. Prof. Gildea presented a paper on "Sand and Anthrafil Filters" at a conference held in the Washington area in May.

Mr. Tilton E. Shelburne, Director of the Virginia Council of Highway Investigation and Research, attended a meeting of the Board of Directors of the American Society of Civil Engineers in Portland, Oregon in June. He traveled to La Salle, Illinois in July to attend regular meetings of the Performance Rating Panel and the National Advisory Committee of the AASHO Road-Test. Mr. Shelburne was active in all preparations made at the University of Virginia for the First International Skid Prevention Conference held September 8 to 12. He was chairman of the sub-

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committee reviewing laboratory and field methods of measuring road surface friction.

Mr. James L. Eades of the Virginia Council of Highway Investigation and Research has been awarded a fellowship by the National Lime Association for study and research at the University of Illinois where he is now located. He will work for the doctors degree under Prof. Ralph Grimm.

Professor David M. Crim of the Civil Engineering Department of Virginia Military Institute has collaborated on writing a text *Engineering Materials* published recently by Pitman.

Professor Arthur Bruce, on leave of absence from the Aeronautical Engineering Department of Virginia Polytechnic Institute, is attending Massachusetts Institute of Technology. He was awarded a fellowship to work for the doctor's degree in aeronautical engineering. During the past summer he was engaged in research for the NACA at Langley Field, Virginia during which time he completed a NACA publication "Smooth Entry Into the Earth's Atmosphere". Professor Robert W. Truitt of the Aeronautical Engineering Department at the Virginia Polytechnic Institute, also was engaged in research for the NACA at Langley Field where he worked on the preparation of a manual "Introduction to Hypersonic Aerodynamics". A paper "Minimum-Drag Cone Frustum at Hypersonic Speeds" by Dr. Truitt appeared in the August issue of *Aero Space Sciences*.

The Chemical Engineering Department of Virginia Polytechnic Institute has announced the appointment of Mr. Donald Puyear as Instructor. Mr. Puyear comes from the Missouri School of Mines. A new bulletin of the Chemical Engineering Department "Anodic Behavior of Nickel, I, Effect of Components of Electrolyte" has been prepared by B. C. Oza and Professor N. F. Murphy.

Professors Otis L. Updike and Robert M. Hubbard of the Chemical Engineering Department of the University of Virginia attended the Golden Anniversary Meeting of the American Institute of Chemical Engineers in Philadelphia in June. Professor Updike is active in work of the Program Committee preparing for a future symposium, and Professor Hubbard is chairman of a committee for Teacher Recruiting and Placement. Professor Hubbard spoke in June to the Virginia Section of the Instrument Society of America in Richmond. In October he attended a conference of college professors at Esso Research and Engineering Company in New Jersey.

The Chemical Engineering Department of the University has announced the appointment of Dr. Harold A. O'Hern and Dr. Robert H. Moen as As-

sistant Professors of Chemical Engineering. Dr. O'Hern comes from the Engineering Experiment Station of the Du Pont Company, and Dr. Moen comes from the Petroleum Development Division of Esso Research and Engineering.

— Robert M. Hubbard, *University of Virginia*

GEOLOGY

Gilles O. Allard joined the staff of the Geology Department at the University of Virginia in September 1958 as assistant professor. He received his B. A. and B. Sc. (geology) from the University of Montreal, his M. A. from Queen's University in 1953 and his Ph.D. from the Johns Hopkins University in 1956. He has been working in the Chibougamau area, northern Quebec, since 1952, first for the Quebec Department of Mines doing detailed mapping, and then as Superintendent of field operations for Chibougamau Mining and Smelting, an active exploration company. Mr. Allard's main interests are economic geology and petrology.

R. S. Mitchell, at the University of Virginia, is completing a two-year research project entitled "A Study of Polytypism and Its Relationship to the Theory of the Spiral Growth of Crystals" which is financed by a Research Corporation Frederick Gardner Cottrell grant. Papers completed under this project are "A Correlation between Theoretical Screw Dislocations and the Known Polytypes of Silicon Carbide," *Zeitschrift fur Kristallographie*, 109, 1, 1957; "Cadmium Bromide: Growth Spirals and Possible Polytypism", *Nature*, 182, 337, 1958; and "A Study of a Silicon Carbide Crystal Containing a New Polytype, 27H," *Zeitschrift fur Kristallographie*, in press, 1958. Structural polytypism in lead iodide is currently being investigated.

"Industrial Limestones and Dolomites in Virginia: James River District West of the Blue Ridge", by R. S. Edmundson has been published by the Virginia Department of Conservation and Development as Bulletin 73 of the Division of Mineral Resources, Charlottesville, Virginia. The bulletin is accompanied by a colored geologic map.

New geology staff member at Washington and Lee University is Dr. Kenneth F. Bick, assistant professor. Dr. Bick has carried out stratigraphic studies in the westward extension of the Unita Mountains in Utah and Nevada.

Four undergraduates from the Washington and Lee University Geology Department accompanied Dr. Edgar Spencer to Montana last summer. Dr. Spencer's studies of Precambrian geology and structural history of the

Madison Range will continue for two more years under a National Science Foundation grant.

The largest undergraduate geology class in Washington and Lee history was graduated last June, a total of 14 seniors, more than a third of which went on to graduate school at Michigan and Columbia.

Washington and Lee's geology department will occupy new modern quarters in another year. The department will be assigned two floors and share a new science building with the biology department under the University's recently announced expansion plans.

A social item from Lexington: Miss Elizabeth Humphries became the bride of Dr. Edgar Spencer on November 26th.

The Department of Geological Sciences at the Virginia Polytechnic Institute has enrolled a record number of graduate students this year. A total of 23 graduate students currently are working on advanced degrees and 7 of these are candidates for the Ph.D. The number of field mapping problems being pursued actively in Southwest Virginia has thereby tripled.

Dr. Jack A. Redden joined the Virginia Polytechnic Institute of Geological Sciences on September 1 as a permanent addition to the staff. Dr. Redden is a graduate of Dartmouth College and obtained his Ph.D. degrees from Harvard University. He has been employed by the U.S. Geological Survey for ten years as petrologist and economic geologist working in the Black Hills area, South Dakota. Dr. Redden is particularly interested in pegmatites, metamorphic petrology, and structural geology. He will be partly responsible for instruction at the Summer Field Station at Saltville.

A record number of students attended the Virginia Polytechnic Institute Summer Field Course at the Saltville Field Station last summer. Some 31 students from seven states were enrolled. The staff included Dr. B. N. Cooper, Director, Dr. B. W. Nelson, Dr. C. E. Sears, and Prof. C. G. Tillman.

Dr. R. V. Dietrich, Professor of Geology at the Virginia Polytechnic Institute, left in August with his family for a year's study at the Mineralogical Institute, University of Oslo, Norway, under a Fulbright research professorship.

Dr. C. E. Sears conducted the geology sessions for the Summer Institute for High School Science Teachers held at the Virginia Polytechnic Institute for the second successive year under auspices of the National Science Foundation.

Dr. B. N. Cooper, head of the Virginia Polytechnic Institute Depart-

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ment of Geological Sciences, traveled extensively during the summer to study special economic aspects of limestone and shale deposits in Texas, Kansas, Indiana, New York, Maryland, and Alabama. He also completed a special report on ground water for the Virginia Advisory Legislative Council. Preceding the meeting of the Geological Society of America Council, of which he is a member, Dr. Cooper gave a special lecture to the faculty and graduate students at the University of Wisconsin at Madison, Wisconsin.

Professor C. G. Tillman of the Virginia Polytechnic Institute spent the latter part of the summer in Cambridge, Massachusetts, continuing his studies of Middle Silurian invertebrate faunas.

Dr. W. D. Lowry of the Virginia Polytechnic Institute spent the summer finishing his extensive report of structural and stratigraphic geology of parts of eastern Oregon. This report soon will be published by the Oregon Geological Survey.

Dr. B. W. Nelson of the Virginia Polytechnic Institute spent two months in Wyoming making a stratigraphic and mineralogical study of bentonites under the faculty supplementation program of the Gulf Oil Company. His research work on sedimentary processes and geochemistry of the Virginia estuaries has been given renewed support by the American Petroleum Institute and the Chesapeake Corporation of Virginia.

—Bruce W. Nelson, *Virginia Polytechnic Institute*

STATISTICS

Dr. Boyd Harshbarger, Head of the Department of Statistics at the Virginia Polytechnic Institute, was chairman of one of the sessions of the Fourth Conference on Design of Experiments at the Quartermaster Research and Engineering Center, Natick, Massachusetts. This conference was sponsored by the Army Mathematics Steering Committee.

The Department of Statistics of the Virginia Polytechnic Institute was the recent recipient of a grant for \$3,500 from the Smith, Kline and French Foundation to support research in biometry.

Dr. Herbert A. David of the Virginia Polytechnic Institute was appointed an associate editor for *Biometrics*.

Recipients of Ph.D. degrees in Statistics at the Virginia Polytechnic Institute in June, 1958, were as follows: John J. Gart, Robert Riffenburgh, and Willard O. Ash.

Mary B. McGahey, John P. Robinson, and Charles A. Bruce completed

their work for their Master of Science degree in Statistics at the Virginia Polytechnic Institute; and Leroy S. Brenna completed his work for the Ph.D. degree in Statistics.

The Virginia Academy of Science Chapter of the American Statistical Association and the Richmond Section of the American Society for Quality Control held a joint one day meeting at the Holiday Inn Restaurant near Lynchburg on October 25.

The Statistics Section at the Institute of Textile Technology has been enlarged with the purchase of a Burroughs Electro Data E-101-3 electronic computer, for use in statistical analysis work.

Mr. David Regnery Myers completed his M.S. thesis at the Institute of Textile Technology, under the title: "The Influence of Doublings and Draft on the Long-and Short-Term Weight Variations of Sliver and Subsequently Processed Yarn." Mr. Meyers is now with Joanna Cotton Mills Company, Joanna, S. C.

Textile Research Journal of July 1958 published a paper by N. L. Enrick of the Institute of Textile Technology, and former Institute Student W. D. Hicks, now with Fieldcrest Mills, Leaksville, N. C. on "Variations in Roving Weight Introduced by the Slubber."

Mill Test Procedures is the title of a new book by N. L. Enrick, published by Rayon Publishing Corporation, based on a series of articles appearing in prior issues of *Modern Textiles Magazine*.

N. L. Enrick attended the Fall Meeting of the American Society for Testing Materials, Committee D-13, to chair the Task Group on Yarn Imperfection Counters and participate in the work of the statistical group, Subcommittee B-5.

— Clyde Y. Kramer, *Virginia Polytechnic Institute*

THE ANNUAL SUBSCRIPTION RATE is \$3.00, and the cost of a single number, \$1.00. Reprints are available only if ordered when galley proof is returned. All orders except those involving exchanges should be addressed to Charles F. Lane, Stevens Hall, Longwood College, Farmville, Virginia. The University of Virginia Library has exclusive exchange arrangements, and communications relative to exchange should be addressed to The Librarian, Alderman Library, University of Virginia, Charlottesville, Virginia.

NOTICE TO CONTRIBUTORS

Contributions to the Journal should be addressed to Robert T. Brumfield, Stevens Hall, Longwood College, Farmville, Virginia. If any preliminary notes have been published on the subject which is submitted to the editors, a statement to that effect must accompany the manuscript.

Manuscripts must be submitted in triplicate, typewritten in double spacing on standard 8½" x 11" paper, with at least a one inch margin on all sides. Manuscripts are limited to seven pages, with the proviso that if additional pages are desired, the author may obtain them at cost. The author may estimate the length of his paper by counting the total number of characters, including blank spaces, and dividing this by 3300. The result is the approximate number of printed pages in the Journal.

Division of the manuscripts into subheadings must follow a consistent plan, and be held to a minimum. It is desirable that a brief summary be included in all manuscripts.

Footnotes should be included in the body of the manuscript immediately following the reference, and set off by a dashed-line above and below the footnote content. Footnotes should be numbered consecutively from the beginning to the end of the manuscript.

Bibliographies (Literature Cited, References, etc.) should be arranged alphabetically according to author. Each reference should include the date, full title of the article, the name of the Journal, the volume, number (optional), pages, tables and figures (if any). For example: "Sniffen, Ernest W. 1940. Cobbles from the Pleistocene Terraces of the Lower York-James Peninsula Va. *Journ. Sci.*, 1 (8): 235-238 1 fig., 1 tab. Reference to the bibliographic citations should not be made by numbers. Instead, using the above citations, where a reference is desired: either "Sniffen (1940)", (Sniffen, 1940: 186)", or "Sniffen (1940) states that . . ."

Explanation of figures, graphs, etc., should be typed on separate pages. All figures should be numbered consecutively beginning with the first text figure and continuing through the plates. If figures are to be inserted in the text this should be clearly indicated by writing "Figure —" at the appropriate place in the margin.

Illustrations including lettering, should be arranged so that on reduction they will not exceed the dimensions of the maximum size of a printed page. 4-1/2" x 6-1/2", and so that they are well balanced on the page. Large plates must be accompanied by 8-1/2" x 11" photographic copies which can be sent to the reviewers. The Journal will furnish the author with one plate (halftone or line reproduction) or its equivalent; additional figures, colored illustrations or lithographs may be used only if the author makes a grant covering the cost of production. Original drawings (which must be done in black drawing ink) not photographs of drawings, should accompany the manuscript. Photographs should not be used if a line and dot (stippled) drawing will suffice. If photographic prints are to be used they should be glossy, sharp and show good contrast. Drawings not neatly executed and labeled (do not use a typewriter), or which are submitted on yellow or yellowish-white paper will not be accepted.

Galley Proofs and engraver's proofs of figures are sent to the author for correction. Costs of excessive changes from the original manuscript must be defrayed by the author.

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C O N T E N T S

	<i>Pages</i>
Characters Differentiating Common Morning-Glories Occurring in Virginia — Robert J. Knight, III	63
A Study of The Chlorophyta of the James River Basin, Virginia — Bernard Woodson, Jr.	70
News and Notes	83
Program of the Thirty-Seventh Annual Meeting of the Virginia Academy of Science	101

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CHARACTERS DIFFERENTIATING COMMON MORNING-GLORIES OCCURRING IN VIRGINIA¹

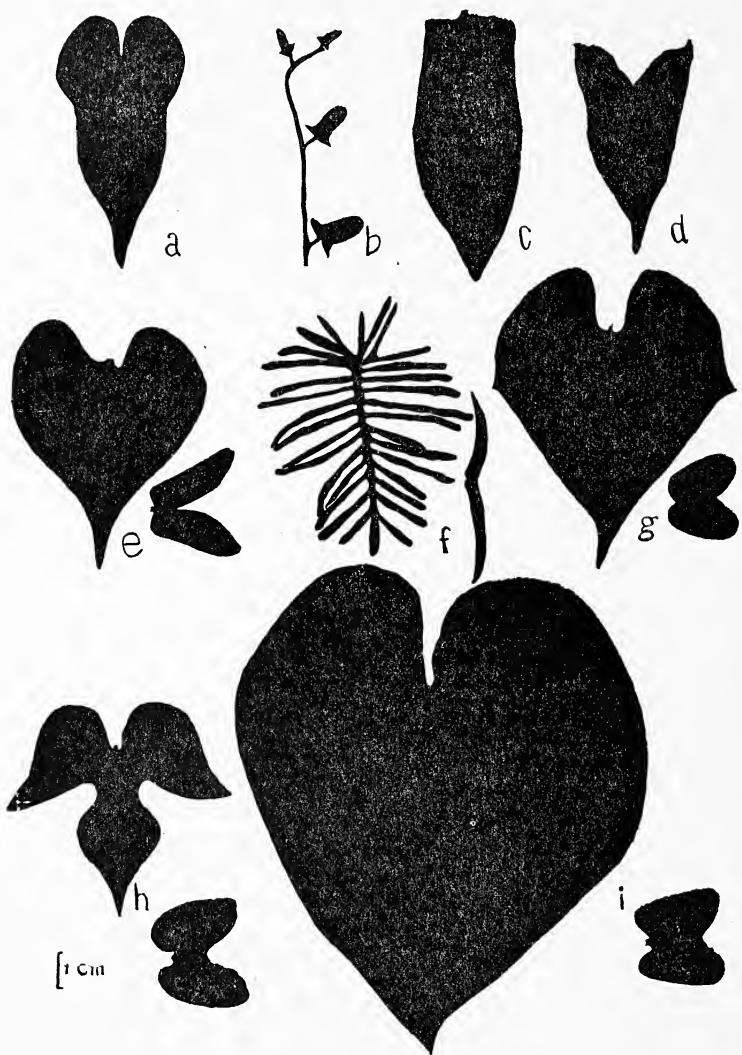
ROBERT J. KNIGHT, III²

The Blandy Experimental Farm, Boyce, Virginia

A few species in the Convolvulaceae are numerically abundant in Virginia. These morning-glories and bindweeds are in greatest evidence as seedlings or blooming and maturing plants during the warm months of the year. During the course of a study of evolutionary trends in the family, a key was prepared for diagnosing the taxa most common in northern Virginia. It is believed that this may be of use in determining the identity of specimens encountered in the field in most parts of the State. An artificial key is used rather than one based on putative phylogenetic relations, because this method appears to the author to be the simplest procedure for rapidly determining identities of living specimens. If the treatment common in Europe were followed (Van Ooststroom, 1938; Hallier, 1893), three species discussed here would be placed in *Calystegia* which is not usually given generic standing in North America (Fernald, 1950; Lawrence, 1951; Gleason, 1952). These species are listed here as *Convolvulus sepium*, *C. spithameus* and *C. Purshianus* Wherry. There seems to be some justification for the European practice when one considers the relative size and position of bracts, and volume of pollen grain in relation to length of style in these three species. Nevertheless at present and pending additional taxonomic studies of the group, it is believed advisable to follow the usual American procedure and retain them within the genus *Convolvulus*.

¹ The author gratefully acknowledges the counsel and support of Dr. W. S. Flory, Jr., who directed his graduate research at The Blandy Experimental Farm. This paper is a portion of a dissertation submitted to the University of Virginia in partial fulfillment of requirements for the Ph.D. degree.

² Present address: U.S.D.A. Agricultural Research Service, Crops Research Division, Beltsville, Maryland.



In southern Virginia near the coast one might occasionally encounter the cypress-vine, *Quamoclit pennata* (Desr.) Voigt. The cypress-vine itself is not included in the present key because of its comparative rarity when the entire State is considered. This species is unmistakably identified by its finely-divided pinnate leaves (fig. 1 f, leaf-blade and cotyledon) and the dark red, star-shaped flowers. White flowers are also known.

On shale formations in western Virginia and West Virginia, *Convolvulus Purshianus* Wherry (*Calystegia tomentosa* Pursh) occurs. This species is readily recognized by the dense silvery tomentum on the leaves. The leaves remain folded together for much of their length, and this makes them appear wilted even when moisture relations are normal.

The annual versus perennial growth habit can be determined by following a given shoot into the soil. In annual species, the cotyledons persist until the plant is quite large; even though the cotyledons may have fallen they leave two prominent, oppositely-oriented scars near the soil line. The true leaves are alternately arranged in morning-glories, and therefore leave no scars directly opposite each other upon falling. Thus a Convolvulaceous plant without visible cotyledons or their scars is immediately classed as perennial.

The habit of promiscuous rooting from widely proliferating underground rhizomes affords a useful means of distinguishing *Convolvulus* from the only perennial *Ipomoea* occurring throughout Virginia, *I. pandurata*. The large fleshy taproot of this species may terminate as much as 30 to 40 centimeters below the soil's surface. Though several shoots may arise from a given root, they can all be traced back to a common point of origin. These shoots are true stems, bearing nodes below ground. They produce no roots above the point of attachment to the taproot.

Within the annual species, the only problem of identification likely to be encountered is that of differentiating *Ipomoea purpurea* from *I. hederacea*. It is believed that the accompanying key and the descriptive

Figure 1. Outlines of leaf-blades of nine, and cotyledons of five morning-glory species occurring in Virginia: a. leaf-blade of *Ipomoea pandurata*; b. shoot of *Convolvulus arvensis*, bearing 4 leaves; c. leaf-blade of *Convolvulus spithamea*; d. leaf-blade of *C. sepium*; e. leaf-blade and cotyledon of *Ipomoea lacunosa*; f. leaf-blade and cotyledon of *Quamoclit pennata*; g. leaf-blade and cotyledon of *Q. coccinea*; h. leaf-blade and cotyledon of *Ipomoea hederacea*; i. leaf-blade and cotyledon of *I. purpurea*.

information immediately following it will make this problem less difficult.

A KEY TO THE MORNING-GLORIES COMMON IN VIRGINIA

A. Perennial

- B. Individual plants arising from single large fleshy taproot, rarely spreading by underground rhizomes *Ipomoea pandurata*.
- B. Individual clones spreading widely by means of underground rhizomes; roots finely divided, no single large taproot C
- C. Bracts small, inconspicuous, well below the calyx *Convolvulus arvensis*
- C. Bracts large, enveloping sepals and later capsule as it develops D
- D. Erect habit of growth, producing many short stems *C. spithameus*.
- D. Twining habit of growth *C. sepium*.

A. Annual

- B. Flowers orange or scarlet, salverform with exerted pistil and stamens; sepals tapering into long, spurlike projections *Quamoclit coccinea*.
 - B. Flowers not orange or scarlet, funnelform with included pistil and stamens; calyx without spurlike projections C
 - C. Flowers small (1.5 to 2 cm. long by 1 to 2 cm. in diameter), white or pale purple, ovary 2-celled *Ipomoea lacunosa*.
 - C. Flowers larger than above (tube 2.5 cm. or longer, limb 3.0 cm. or more in diameter), blue, purple, red or white; ovary 3-celled D
 - D. Flowers blue, never with 5 dark lines in throat, relatively small (tube 2.5 to 5.0 cm., limb 2.5 to 4.0 cm.), leaves usually 3-lobed; ripened ovary never depressed *I. hederacea*.
 - D. Flowers purple, red, blue, or white, almost always with 5 dark lines in throat, relatively large (tube 4.0 to 6.0 cm., limb approximately the same); leaves usually entire, not lobed; ripened ovary almost always depressed *I. purpurea*.
1. *Ipomoea pandurata* (L.) G. F. W. Meyer. Leaves cordate to panduriform, glabrous or finely pubescent, with conspicuous dark vein-

ing; stems uniformly dark brown to purple; calyx glabrous, fleshy, adhering closely to base of flower; corolla funnel-shaped, tube from 5 to 8 cm. long, limb of approximately the same width, white; interior of tube maroon; stigma 2-parted; often fails to set seed, thus late in season may exhibit many barren peduncles from which flowers have fallen. Occurs in cultivated fields, along roadsides, in power company rights-of-way and other cleared areas. Blooms in Clarke County from earliest summer to frost. Leaf-blade outline (fig. 1 a).

2. *Convolvulus arvensis* L. Corolla bell-shaped, small (1.5 to 2.0 cm. long by about same width), white or sometimes pinkish; plant finely pubescent or glabrous, having small, rounded-triangular to conspicuously sagittate leaves, from 2 to 5 cm. long by 2 to 3.5 cm. wide; leaves vary much in shape and size from one clone to another (Brown, 1946); plant generally fine in scale, of a dark grayish-green color. A frequent pest in lawns and gardens, common in moist soil along roadsides and ditchbanks. Blooms, moisture supply permitting, from early summer to frost. Individual clones, isolated, set few if any seed. Outline of shoot with leaves (fig. 1 b).

3. *Convolvulus spithameus* L. Leaves oblong or slightly narrower at base than middle, pubescent; corolla large, white or pinkish, bell-shaped (4 to 7 cm. long by about same width). Common along Skyline Drive in mid-June. Leaf-blade outline (fig. 1 c). [Closely related to this species, if not a form of it, is *Convolvulus Purshianus* Wherry (*Calyptegia tomentosa* Pursh), with persistently conduplicate leaves bearing a thick, silvery pubescence; an inhabitant of shale areas in western Virginia.]

4. *Convolvulus sepium* L. Entire plant glabrous, of a bright green color; peduncles rectangular in cross-section; leaves large (5 to 10 cm. long by 3 to 7.5 cm. wide), usually triangular or sagittate, with one or two sharply defined angles at the base; veins depressed, giving leaves a reticulate appearance; flowers large (4 to 7 cm. long by about same width), white or pink. Abundant in old cornfields or other areas long in cultivation, often occurring along fencerows. Blooms in Clarke County from the third week in June until frost. Leaf-blade outline (fig. 1 d).

5. *Quamoclit coccinea* (L.) Moench. Readily determined from color of corolla and, after blooms have faded, by the long spurlike awns which terminate the sepals; ripening and mature ovary depressed; leaves usually cordate, entire or very shallowly trilobed, but in form *hederifolia* House are deeply 3- to 5-lobed. Immature plants can be distinguished from species of *Ipomoea* which might be present by the lighter green, almost yellowish cast of the *Quamoclit* plants, in contrast to the darker green color characteristic of *Ipomoea* seedlings. *Quamoclit coccinea* is oc-

casional in cultivated fields. Blooms in Clarke County from mid-August until frost. Outline of leaf-blade and cotyledon (fig. 1 g).

6. *Ipomoea lacunosa* L. Flowers inconspicuous, closing early in day, often hidden in foliage; corolla most often white, but may be a pale purple; leaves most often entire, not lobed, but may be shallowly 3-lobed or, rarely, 5-lobed; cotyledons deeply divided, with narrow lobes which flare widely; sepals thin but tough and rigid as opposed to soft, herbaceous calyx of other annual species of *Ipomoea*. Blooms from late June to October at Blandy Farm. Only white flowers have been observed in Clarke and Warren Counties, but the mauve-colored forma *purpurata* Fernald has been collected in Albemarle County. Outline of leaf-blade and cotyledon (fig. 1 e).

7. *Ipomoea hederacea* (L.) Jacquin. Leaves usually 3-lobed in this part of the range, occasionally unlobed or 5-lobed; cotyledon lobes ordinarily not widely flared, but sulcus between lobes is usually relatively deep; entire plant is usually thickly covered with coarse, straw-colored hairs, calyx particularly well supplied with tomentum so that glands though present are not always readily visible; edges of sepals rolled together making a cross-section of the portion of the sepal which projects beyond the ovary U- or horseshoe-shaped; rarely exhibits abundant pigment in stem above cotyledons, and never in abruptly distinct patches; ordinarily no more than 3 flowers to a single peduncle, often only one. An abundant weed in cultivated fields and recently disturbed ground, but appears unable to compete with other plants in sod or woodland. This species has usually finished blooming, and ripened its seed crop well before the first frost in autumn. Outline of the type of leaf-blade most frequently observed and of cotyledon. fig. 1 h.

8. *Ipomoea purpurea* (L.) Roth. Leaves usually entire in this part of the range, but may be deeply 3- or 5-lobed; cotyledon lobes never widely flared, and sulcus between lobes is relatively shallow; entire plant is sparsely puberulous, thus glands on calyx usually appear prominent; individual sepals flattened in cross-section, not involute; cross-section of sepal may be crescent-shaped, but is never U- or horseshoe-shaped; stems frequently display long patches of dark purple pigment on the side exposed to sunlight (even in white-flowered specimens), with an abrupt line of demarcation between pigmented area and the pale green portion of stem that is ordinarily shaded; frequently as many as 5 flowers in one inflorescence. Common weed in fields and gardens, but apparently cannot persist in grassland or woods: "Crimson Rambler," "Rose Marie," and "Tinkerbell's Petticoat" are all cultivated forms of this species. Continues to bloom profusely in autumn till frost. Outline of leaf-blade and cotyledon, fig. 1 i.

LITERATURE CITED

- Brown, E. D. 1946. Notes on some variations in field bindweed (*Convolvulus arvensis* L.) *Iowa State Coll. Jour. Sci.* 20: 269-276.
- Fernald, M. L. 1950. Gray's Manual of Botany. Eighth Ed. American Book Co. New York. 1632 pages.
- Gleason, H. A. 1952. The New Britton and Brown Illustrated Flora. Vol. 3. New York Botanical Garden. New York. 589 pages.
- Hallier, H. 1893. Versuch einer naturlicher Gliederung der Convolvulaceae. In Engler's botan. Jahrbucher 16: 453-591.
- Lawrence, G. H. M. 1951. Taxonomy of Vascular Plants. Macmillan. New York. 823 pages.
- Van Ooststroom, S. J. 1938. The Convolvulaceae of Malaysia, I. *Blumea* 3: 62-94.

A STUDY OF THE CHLOROPHYTA OF THE JAMES RIVER BASIN, VIRGINIA¹

I. COLLECTION POINTS AND SPECIES LIST.

BERNARD WOODSON, JR.

Virginia State College

OBJECTIVES OF THIS STUDY

This is an investigation of the distribution, classification and ecology of the Chlorophyta of the James River Basin. The primary objectives of this work have been: (1) the collection and identification of green algae (Chlorophyta) from representative points along the James River Basin; (2) the determination, where possible, of the geological or soil features and chemical factors related to the distribution of Chlorophyta along the James River Basin; and, (3) the assembling of ecological data concerning algal development in the streams concerned in general.

Need for this work was brought to the attention of the writer by his advisor, Dr. G. W. Prescott. It was suggested that since no formal study had been made on the distribution and ecology of green algae in the area covered by this report, that it would be well to make such a survey. Several persons have reported organisms from different points in Virginia, but for the Chlorophyta along the James River Basin it is virgin territory. J. C. Strickland, (1942)², has made a survey of blue-green algae, H. S. Forest (1954) has presented a check list of algae in the vicinity of Mountain Lake Biological Station, Virginia, S. L. Meyer (1940) has reported species of Phacus, and Vivian Farlow (1928) has reported on algae of ponds, from tadpole intestine. It was also suggested by Dr. Prescott that the writer try to associate as many factors (ecological, parent rock, soil regions, water chemistry, etc.) with the distribution of the Chlorophyta along the James River Basin as possible. The investigation was started during the summer of 1955.

THE PRESENT STUDY — The results of the complete study will be published in several articles. The present article will list in detail the collection points, as well as the 89 species of Chlorophyta encountered.

METHODS AND PROCEDURE — In order to carry out the major objectives of this problem, representative water samples were collected from points along the James River. This was done by taking samples

¹ A survey made as partial fulfillment for the requirements for the Ph.D. degree at Michigan State University.

² Literature citations will appear in a later paper in this series.

from tributaries emptying into the James River on both sides making certain that all main streams were represented from headwaters to the mouth of the river.

The distance from origin to mouth of the James is approximately 300 miles, but it was necessary to travel over one thousand miles to make a complete survey of the area studied for each sampling period.

The first collections were made in August of 1955. Samples were taken from both sides of the James making certain that representative samples were taken from each county bordering the river. This was done mainly with the desire of obtaining samples from each parent soil type. As shown by the soils map, many of the counties had the same physiography.

At least two, often many more, samples, however, were taken from streams emptying into the James from each county. This procedure was adhered to as closely as possible, for the winter collection 1955-56 and spring collection 1956. A total of 97 points were sampled by the author, and Dr. Strickland of the University of Richmond contributed 16.

In surveying the tributaries, all macroscopic algal growth were sampled. In many instances soil samples of stream bottoms were collected even though there was no definite sign of algal growth. Also samples of twigs, leaves, rocks or other debris were collected for examination. Observations were made as to the speed of the currents of the streams, type of bottom and where possible, the various species or genera of higher plants of the stream and bordering banks. Plankton samples were also obtained from many of the larger bodies of water. The samples were preserved in Transeau's solution, known as 6-3-1 (6 parts water, 3 parts ethyl alcohol and 1 part commercial formalin).

In the summer of 1956, the author again covered the same distance taking samples of water from the main tributaries for chemical analyses and also taking the pH of the explored streams. The chemical analyses of these waters had already been made by the Department of Conservation, Division of Water Resources, but phosphorus analyses had been omitted from the data by the Conservation Department of Virginia; therefore, the author made phosphorus determinations using the "Molybdate Colorimeter Method."

The materials collected were examined in the laboratory and the species found in each collection were recorded. A drawing of each species observed was made with the camera lucida.

COLLECTION POINTS — The several points, with brief remarks concerning each are listed below. Following these data will be found the taxonomic list, which includes 89 species with collection points of each taxa being indicated.

No.	Location	Stream Profile	Higher aquatics
1	Rt. 147 — stream draining Richmond Country Club.	Slow flowing, sandy	None
2	Creek draining dam off Rt. 147, $\frac{1}{4}$ mile south of James River, Chesterfield Co.	Slow flowing, muddy	None
3	Creek and Small Lake, 10 miles West of Richmond, Chesterfield Co.	Slow flowing, muddy	Reed grass, sumac and others
4	Bernard's Creek, Rt. 711 Powhatan Co.	Slow flowing, sandy	<i>Veronica</i> sp.
5	Norwood Creek, Rt. 711, Powhatan Co.	Slow flowing, sandy	None
6	Fine Creek, Rt. 711, Powhatan Co.	Slow flowing, rocky and sandy	Moss growth, <i>Veronica</i> sp.
7	Beaver Dam Creek, Rt. 6, Goochland Co.	Swift, rocky	None
9	Tuckahoe Creek, Rt. 6, Goochland Co.		None
10	Creek $\frac{1}{4}$ mi. E. of Rt. 147 on Riverside Drive, Henrico Co.	Rocky, slightly swift	None
11	Falling Creek, Rt. 1, Chesterfield Co.	Rocky and swift	None
12	Kingland Creek, Rt. 1, Chesterfield Co.	Rocky, swift	None — seemed polluted
13	Appomattox River, Hopewell, Va., Prince George Co.	Sandy, mucky, slow flowing	Marsh, water lillies, Reed grass, etc.

- | | | |
|---|---------------------------|---|
| 14 Small Creek W. of Turkey Island on Rt. 5, Henrico Co. | Rocky, fairly swift | <i>Sparganium</i> sp. |
| 15 Turkey Island Creek, Rt. 5, Charles City Co. | Sandy, slow | <i>Potamogeton</i> sp. |
| 16 Herrin Creek, Rt. 5, Charles City Co. | Rocky, sandy and swift | Moss vegetation |
| 17 Gunns Run, Rt. 5, Charles City Co. | Rocky and swift | <i>Veronica</i> sp. |
| 18 Creek Rt. 5 between Gunns Run and Morris Creek, Charles City Co. | Rocky and fairly swift | <i>Potamogeton gramineus</i> |
| 19 Morris Creek, Rt. 5, Charles City Co. | Sandy, rather swift | <i>Sparganium</i> sp. |
| 20 Chickahominy River, Rt. 5, James City Co. | Sandy and slow | <i>Elodea canadensis</i> ,
<i>Valisneria</i> sp.
<i>Cyperus americana</i> |
| 21 Overflow from Matoaka Lake, Williamsburg, Va., Rt. 31. | Silty, slightly swift | <i>Ceratophyllum demersum</i> |
| 22 Water Creek, Warwick Co. Rt. 60 | Muddy and slow | None |
| 23 Mouth of James River — Hampton Roads | Highly salty and sandy | None |
| 24 Cypress Creek, Smithfield, Va. Isle of Wight Co. | Sandy, swift and brackish | Reed grass, rushes, etc. |
| 26 Creek W. of Lawny Creek on Rt. 10 Surry Co. | Sandy and fairly swift | None, algal growth on shells & debris |
| 27 Cypress Swamp, Rt. 10, Surry Co. | Rocky and slow | Water cress |

28 Ward's Creek, Rt. 10, Prince George Co.	Rocky and swift	<i>Potamogeton gramineus</i> , <i>P. Illinoisensis</i> , <i>Heteranthera dubia</i>
29 Powells Creek, Rt. 10, Prince George Co.	Slow, muddy	<i>Potamogeton pusillus</i>
30 Chickahominy River, Rt. 60, New Kent Co.	Muddy and fairly swift	<i>Carex</i> sp., <i>Typha latifolia</i> and <i>Potamogeton</i> sp.
32 Cheney's Creek, Rt. 6, Goochland Co.	Swift and sandy	None
33 Byrd Creek, Rt. 6, Goochland Co.	Fairly swift, rocky and sandy	None
34 Rivanna River, Rt. 6, Fluvanna Co.	Swiftly flowing and rocky	<i>Ranunculus</i> sp.
35 Hardware River, Rt. 6, Fluvanna Co.	Rocky and swift	<i>Lythrum</i> sp.
36 Muddy Creek, Rt. 20, Buckingham Co.	Muddy, swift	None, Algae growing on rocks
38 Small stream W. of Willis River on Rt. 60, Buckingham Co.	Muddy, slow	None, Algae on rocks and side of banks
39 Willis River, Rt. 60, Cumberland Co.	Slow and muddy	None
40 Deep Creek, Rt. 60, Cumberland Co.	Slow and muddy	None
41 Falling Creek, Rt. 60, Chesterfield Co.	Fairly swift, mucky	None
42 Appomattox River, Petersburg, Va.	Fairly swift, rocky and polluted	None
44 Swift Creek, Rt. 1, Chesterfield Co.	Swift and rocky	<i>Veronica</i> sp.

45 Appomattox River, Two mi. above Petersburg in Chesterfield Co.	Quite swift and rocky	None, seemed polluted.
46 Swift Creek, Rt. 602, Chesterfield Co.	Fairly swift and rocky	None, algae on rocks and soil
47 David Creek, Rt. 60, Appomattox Co.	Fairly swift, slate rock	None, Algae on rocks and soil
48 Bent Creek, Rt. 26, Appomattox Co.	Swift and rocky	None, Algae on rocks, branches and soil
50 Little Beaver Creek, Rt. 460, Campbell Co.	Swift and rocky	None, Algae on debris and rocks
51 Appomattox River, Rt. 24, Appomattox Co.	Swift and rocky	None
52 Judith Creek, Rt. 501, Bedford Co.	Swift and sandy	None
53 Battery Creek, Blue Ridge Pkway, Rockbridge Co.	Swift and rocky	None, algae on rocks
54 Looney Creek, Rt. 220, Botetourte Co.	Swift and rocky	<i>Juncus</i> sp., Chicory, <i>Labiatae</i> , legumes All overhanging.
55 Catawba Creek, Rt. 220, Botetourte Co.	Slow, muddy	<i>Spirogyra</i> sp.
56 Lapsley Run, Rt. 220, Botetourte Co.	Swift and rocky	None, grasses, golden rods and willows overhanging
57 Craigs Creek, Rt. 220, Botetourte Co.	Swift and rocky	<i>Potamogeton</i> sp. <i>Elodea</i> <i>canadensis</i> , <i>Lysimachia</i> sp. and <i>Chara</i> sp.

58 Mills Creek, Rt. 220, Botetourte Co.	Swiftly flowing, rocky	None, seemed polluted.
59 Sinking Creek, Rt. 220, Botetourte Co.	Slow flowing with shale bottom	None, algae on rocks
60 Jackson River, Rt. 60, Allegheny Co.	Swift, rocky	Heavily polluted, algae on rocks. <i>Veronica</i> sp.
61 Ogle Creek, Allegheny Co.	Swift, rocky	None, Good growth of algae under bridge and near banks
62 Wilson Creek, Allegheny Co.	Swift, rocky	None. Algae on rocks
63 Cow Pasture River, Rt. 60, Allegheny Co.	Swift, rocky	<i>Potamogeton</i> , <i>Lysimachia</i> sp.
64 Simpson Creek, Rt. 60, Allegheny Co.	Swift, rocky	None
65 Keers Creek, Rt. 60, Allegheny Co.	Slow, rocky	None
66 Pedlar River, Rt. 60, Amherst Co.	Swift, rocky	Liverworts, mosses, Algae on rocks
68 Rockfish River, Rt. 29, Nelson Co.	Swift, muddy	None. Poor algal growth on rocks, debris
69 Westhampton Lake, University of Richmond		
70 Temporary Pool — Huguenot Bridge Chesterfield Co.		
71 Granite Quarry — Chesterfield Co.		

72 Ditch along railroad — Northside of James River, Henrico Co.

73 Swamp, 10 miles west of Richmond, Rt. 6, Henrico Co.

74 Maury River, Rt. 60, Buena Vista, Va.

Quite large, slow
and muddy

Potamogeton crispus
Elodea canadensis

Collection points No. 8, 25, 31, 37, 43, 49 and 67 were omitted because no Chlorophyta were found to be present.

TAXONOMIC LIST

(Numbers in parenthesis refer to collection points as listed above.)

Division Chlorophyta

Class Chlorophyceae

Order Volvocales

Family Volvocaceae

Pandorina morum Bory (69)

Eudorina elegans Ehr. (13) (72)

Order Tetrasporales

Family Palmellaceae

Gloeocystis gigas (Kutz) Lagerh (30) (52)

Tetraspora lubrica (Roth) Agardh (14) (15) (16) (28) (29)
(45)

Family Coccomyxaceae

Dispora crucigenioides Printz (65)

Coccomyxa dispar Schmidle (71)

Order Ulothrichales

Family Ulotrichaceae

Ulothrix tenerrima Kutz (11) (12) (27)

U. zonata (Weber and Mohr) Kutz (4) (22) (23) (53) (64)

Family Trentepohliaceae

Lochmium piluliferum Printz (57)

Order Microsporales

Family Microsporaceae

Microspora amoena (Kutz.) Rab. (4) (6) (16) (17)

M. Willeana Lagerheim and Detoni (12)

Order Chaetophorales

Family Chaetophoraceae

Stigeoclonium stagnatile (Hazen) Collins (34)

S. subsecundum Keutzing (1) (10) (11) (12) (15) (69)

Chaetophora elegans (Roth) Agardh (15) (22) (42)

- C. incrassata* (Hads.) Hazen (73)
Draparnaldia glomerata (Vauch.) Agardh (72)
D. platyzonata Hazen (3) (44) (45) (73)
D. plumosa (Vauch.) Agardh (22) (42) (62) (66) (69) (72)

Order Cladophorales

Family Cladophoraceae

- Cladophora callicoma*. Keutz (21)
C. insignis Keutz (54) (64)
Pithophora kewensis Wittr. (42)
Rhizoclonium hieroglyphicum (Ag.) Kutz (20) (32) (35) (42) (74)

Order Ulvales

Family Ulvaceae

- Enteromorpha prolifera* (Fl. Dan.) Agardh (24)
Ulva lactuca Linn. (23)

Order Oedogoniales

Family Oedogoniaceae

- Oedogonium echinospermum* Braun and Keutz (6)
Oe. minor Witt. (13)

Order Chlorococcales

Family Hydrodictyaceae

- Hydrodictyon reticulatum* (L.) Lager. (74)
Pediastrum duplex — var *clathratum* (Braun) Lagerh. (13) (20)
var. *reticulatum* Lagerh. (20)
P. integrum Naegeli (20)
P. simplex (Meyen) Lemmer (61)

Family Coelastraceae

- Coelastrum cambricum* Archer (46)

Family Oocystaceae

- Eremosphaera viridis* DeBary (24)

Family Scenedesmaceae

- Scenedesmus quadricauda* (Turp.) Breb. (22) (46)

Order Zygnematales

Family Zygnemataceae

- Spirogyra aplansopora* Rand. (69)
Sp. cleaveana Traus. (3) (69)
Sp. communis (Hass.) Keutz
Sp. crassa Keutz. (5) (34) (36)
Sp. denticulata Trans. (15)
Sp. insignis (Hass.) Keutz (42)
Sp. mirabilis (Hass.) Keutz (69)
Sp. protecta (2)
Sp. semiornata Jac. (69)
Zygnema insigne (Hass.) Keutz (71)

Family Desmidiaceae

- Closterium acerosum* (Schrank) Ehren. (42)
Cl. abruptum var. *africanum* (West) Kreiger (19) (46)
Cl. Dianae Ehren. (6) (16)
Cl. didymotocum Ralfs. (40)
Cl. Leibleinii Keutz. (6) (69)
Cl. littorale Gay (38) (46) (48) (53)
Cl. moniliforme (Bory) Ehren. (2) (6) (19) (33) (38) (41)
(46) (52) (61) (64) (68)
Cl. Pritchardianum Archer (1) (52) (71)
Cl. praelongum Brab (46)
Cl. rostratum Ehren. (40) (46)
Cl. tumidum Johnson (40) (48) (62) (65)
Cl. tumidulum (40)
Cosmarium formosulum var. *nathorstii* (Boldst.) W. & W. (40)
(54) (56)
Cos. fomosulum Boldst. (54) (56) (57)
Cos. meneghini Breb. (46) (57) (71)
Cos. margaritatum (Lund). Roy & Bliss (59)
Cos. pseudoconnatum Nordst. (40) (58) (59)
Cos. pseudopyramidatum (58)
Cos. punctulatum var. *subpunctulatum* (Nordst.) Berg. (4)
(33) (48) (58) (68)
Cos. subreniforme Nordst. (40)

- Cylindrocystis diplospora* Lund. (71)
Desmidium Baileyi (Ralfs.) Nordst (59)
D. Swartzii Agardh. (6) (7) (16) (57) (59)
Euastrum verrucosum var. *alatum* Wolle (6)
Hyalotheca dissiliens (J. E. Smith) Breb. (3) (15) (28) (38)
(39) (45) (57) (59) (71)
Hy. mucosa (Dillw.) Ehren. (22)
Micrasterias americana (Ehren.) Ralfs. (6)
M. sol. (Ehren.) Keutz (6) (39)
M. truncata (Corda) Breb. (57) (58)
Penium margaritaceum (Ehren.) Breb. (1) (33) (64)
Pleurotaenium cylindricum Ralfs. (6) (39)
Pl. Ehrenbergii (Breb.) DeBary (59)
Staurostrum alternans Breb. (17) (38) (48) (65)
Str. Brebissonii Archer (13)
Str. Dickei Ralfs.
Str. gracile Ralfs. (22)
Str. orbiculare var. *hibernicum* West and West (57)
Str. punctulatum Breb. (66)

Class Charophyceae

Order Charales

Family Characeae

Tribe Nitelleae

Nitella opaca Agardh. (18)

Tribe Chareae

Chara Braunii Gmelin (64)

C. fragilis Desv. and Loisel. (57) (63) (61)

Division Euglenophyta

Class Euglenophyceae

Order Euglenales

Family Euglenaceae

Euglena Spirogyra Ehren. (65)

Division Chrysophyta

Class Xanthophyceae

Order Heterosiphonales

Family Vaucheriaceae

Vaucheria aversa Hass. (15) (19) (69)

V. discoidea Taft. (33) (72)

V. geminata (Vauch.) DeCand. (30) (42)

V. sessilis (Vauch.) DeCand. (14)

Division Rhodophyta

Class Rhodophyceae

Subclass Florideae

Order Nemalionales

Family Batrachospermaceae

Batrachospermum virgatum (Kuetz.) Sin. (4) (9) (16) (17)
(18) (19) (26) (28) (29) (34)

Subclass Bangiodes

Order Ceramiales

Family Ceramiaceae

Ceramium rubrum (Huds.) C. Ag. (23)

Family Erythrotrichiaceae

Compsopogon coeruleus (Balbis) Mont. (5)

Although this is an investigation of the *Chlorophyta*, the author has included in the Taxonomic list several species of *Rhodophyta* and *Chrysophyta*. These species were included because some appeared quite frequently in collections, and it was thought that these forms may be of interest to some biologist.

News And Notes

(Editor's Note: News contributions should be sent to the person whose name appears at the end of the appropriate sections.)

MINUTES OF THE COUNCIL MEETING

Longwood House — October 19, 1958

The Council of the Virginia Academy of Science, together with Committee and Section representatives, met at Longwood House in Farmville, president Forbes presiding.

Council members present were as follows: Ralph A. Bradley, Robert T. Brumfield, Walter S. Flory, Jr., William G. Guy, William M. Hinton, Horton H. Hobbs, Jr., George W. Jeffers, Harry G. M. Jopson, Charles F. Lane, Paul M. Patterson, and Foley F. Smith.

Those representing Committees and Sections were as follows:

Sections:

Franklin D. Kizer, *Science Teachers*.

B. A. Niemeier, *Engineering*

S. S. Obenshain, *Agricultural Science*

W. T. Parrott, *Geology*

William W. Scott, *Biology*

Jackson J. Taylor, *Astronomy, Mathematics and Physics*

Frank A. Vingiello, *Chemistry*

Committees:

L. D. Abbott, Jr., *Business Memberships*

I. G. Foster, *History of Science*

Boyd Harshbarger, *Institute for Prospective College Seniors and Their College Teachers*

J. C. Holmes, *Science Talent Search*

S. P. Maroney, Jr., *Arrangements for 1959*

Sydney S. Negus, *Awards*

Nolan E. Rice, *Resolutions*

Since the minutes had been circulated a motion was passed to dispense with the reading.

The subject of the James River Basin Association tabled at the last meeting was left tabled.

Dr. Harshbarger reported on his conference concerning raising money for an Institute for the Exceptional College Students in the Sciences. It appeared that the National Science Foundation might be interested in this. After considerable discussion the following motion was formulated for Dr. Negus and passed:

That Council accepts and approves the report of The Science Conference Committee of which Dr. Harshbarger is Chairman and directs this Committee to continue their work towards inauguration of this plan with the approval of The Virginia Academy of Sciences. The President is authorized to sign the application for the Academy.

Mr. Foley Smith reported on sales of the "James River Basin" and reprints of the Journal Issue for The Jamestown Festival. Mr. Smith moved that the Committee on James River Project be dissolved. This motion was passed. Future sales of this book, however, would be credited as before.

Mr. Maroney brought up several problems that faced his Planning Committee. One concerned rental that would be charged for use of the Student's Activities Building. Council passed Dr. Flory's motion to the effect that his Committee may use Academy funds for this purpose up to \$400 as they see fit.

Mr. Maroney brought up the question of a tea in the Rotunda. Opinion was somewhat divided but Council approved a tea for May, 8, 1959 at 5-6 p.m.

Dr. Forbes called attention to a letter from A. T. McPherson, President of the District Academy over possible conflict with their Junior Academy and ours in the adjoining Virginia territory where they are active. Council would foresee no conflict and designated President Forbes to reply.

Dr. Jackson Taylor pointed out that there was sentiment among the mathematicians to form an independent Section. He was advised that this is the wishes of the group and is always accepted by the Academy on a two year trial basis as indicated in Article 9 Sections 1 and 2 of the Constitution.

Dr. Bradley formulated a procedural basis for awarding research funds which he plans to publish in the Journal. Council listened with comments which centered chiefly around the eligibility clauses for awards, but reminded him that his Committee was autonomous.

Mr. Lane pointed out that the printing contract for the Journal would soon expire and a new one should be negotiated. Dr. Flory moved that the Editor and Business Manager of the Journal be empowered to do so. This motion was passed.

Dr. Negus reported the Awards Committee had nominated Lloyd C. Bird for the Distinguished Service Award. Dr. Flory put this in the form of a motion and Council approved the nomination unanimously.

Dr. Guy made, and Council passed, a motion that Dr. N. F. Murphy be commended for the outstanding job he did in obtaining commercial exhibits at the 1958 Roanoke meeting.

The President reported that R. W. Engel was appointed to the Research Committee for two years, because of C. L. Gemmill's resignation, and would become Chairman at Gemmill's rotational year (Engle's second) in order to preserve the sequential continuity of this Committee.

President-elect Hinton reported Ed Berkeley is Chairman of the Local Arrangements Committee for the 1960 meeting in Richmond with Jefferson Hotel as headquarters. The Academy speaker, he said, would be Harry Harlow, a student of primates. Adjournment.

Paul M. Patterson, *Secretary*.

AMERICAN TOBACCO COMPANY

Dr. William R. Harlan, Managing Director, Department of Research and Development, The American Tobacco Company, announced the appointment of two supervisors in the Quality Control and Improvement of Products Division. Oswald N. Coty has been named Supervisor of Essential Materials and Ralph R. Chesson, Supervisor of Tobacco Control.

The following personnel changes at the Research Laboratories of The American Tobacco Company were announced by H. R. Hanmer, Vice President, Research Department: William R. Harlan, formerly Assistant Director of Research was named Managing Director, Research and Development. He received his B. S. degree from New Mexico State University and his Doctor's degree in Plant Chemistry from Iowa State College.

Edward S. Harlow was appointed Assistant Managing Director, Research and Alexander W. Schoenbaum, Assistant Managing Director, Development. Both Mr. Harlow and Mr. Shoenbaum are natives of Richmond, Virginia and are graduates of the University of Richmond.

Other appointments, according to the Vice President, were as follows: John M. Moseley, Assistant to Vice President and to Managing Director, Research and Development; Overton L. Hillsman, Executive Assistant; Claiborne E. Brogden, Assistant to Managing Director, Research and Development; Blanton M. Bruner, Assistant to Managing Director, Research and Development; Clarence H. Rayburn, Supervisor of Research; John T. Ashworth, Supervisor of Development.

AGRICULTURAL SCIENCES

Dr. C. J. Ackerman of the Department of Biochemistry and Nutrition, Virginia Polytechnic Institute, participated recently in a conference called by the National Research Council, Washington, D. C., to consider the use of ethylene oxide gas as a sterilizing agent for human blood plasma. Dr. Ackerman's advice was sought because of his recent researches on the effect of the sterilizing gas on the nutritional value of proteins.

W. W. Osborne, Associate Extension Plant Pathologist, Virginia Polytechnic Institute, has been granted two years educational leave to work on his Ph. D. degree in plant pathology. Dr. Robert Pristou is substituting for Mr. Osborne during his leave.

The Department of Vocational Education, Virginia Polytechnic Institute, cooperating with the State Department of Education and the teachers of vocational agriculture, has just completed a follow-up study of approximately 71,000 former students of vocational agriculture. The chief purpose of the study was to answer the question: What becomes of boys who study vocational agriculture in the high school? Copies of the study are available from the Department of Vocational Education.

The National Science Foundation has announced that Dr. M. D. Lane, Associate Professor of Biochemistry and Nutrition, Virginia Polytechnic Institute has been awarded a three-year grant in the amount of \$17,200.00 for the study of the metabolism of fatty acids by animal tissues.

The National Institute of Health has awarded a sum of \$25,530.00 to support basic agricultural research at the Virginia Polytechnic Institute under the direction of Dr. K. W. King in the Department of Biochemistry of Biochemistry and Nutrition. Approximately half of the funds will be used for graduate assistantships. The research is an attempt to learn the details of how bacteria and fungi decompose cellulose. Understanding of the process is intended to lead to ways of improving cattle and sheep nutrition, maintenance of soil fertility, sewage disposal, and cotton fabric preservation.

Dr. R. W. Engel, Head of the Department of Biochemistry and Nutrition at Virginia Polytechnic Institute has been appointed to the Editorial Board of the newly-created scientific journal, *Toxicology and Applied Pharmacology*.

Need for the journal arose from the rapid postwar increase in the use of new chemicals in drugs, cosmetics, food processing, and agriculture. Protection of the public from unsuspected toxic effects of the new chemicals can only be assured by extensive research to establish their safety prior to commercial use. The Journal of *Toxicology and Applied Pharmacology* will serve the scientific world as a means of reporting the results of such research.

James F. Eheart, Associate Professor of Biochemistry, Virginia Polytechnic Institute attended a National Pesticide Residue Conference at Washington, D. C., in January. This meeting was sponsored by the U.S. D.A. and the Federal Food and Drug Administration.

Mr. Robert K. Reynolds has been appointed Assistant Extension Agricultural Economist, Virginia Polytechnic Institute, to work in Farm Management. Mr. Reynolds holds a B. S. degree from Virginia Polytechnic Institute and is now working part-time on his M. S. degree. He served for a period of two years with the Virginia Agricultural Extension Service.

— Carl W. Allen

CHEMISTRY

A new Infra-Cord has just been installed in the physical chemistry laboratory at Virginia Military Institute. The cost of the instrument was partially met by a grant of \$2500 from the Hercules Power Company.

A new lecture room at the Institute, seating 250, is nearing completion and will be ready for occupancy about March 1.

New instructors added to the Virginia Military Institute staff include: Mr. John Borders of Wake Forest, Lt. William Corr, Lt. Theron Henry and Lt. William Sink of Virginia Military Institute.

— M. A. Kise

ENGINEERING

Professors Fred W. Bull and Nelson F. Murphy of the Chemical Engineering Department, Virginia Polytechnic Institute, attended the annual meeting of the American Institute of Chemical Engineers held in Cincinnati, Ohio in December. Professor Bull has announced the appointment of Dr. Stuart B. Row as Professor of Chemical Engineering.

Dr. Row received his B. S. and M. S. degrees from the Virginia Polytechnic Institute and his Ph.D. from Ohio State University. Formerly he taught at the Virginia Polytechnic Institute and at Southwestern Louisiana Institute of Technology. He has most recently been employed by the American Viscose Company and O'Sullivan Rubber Company. Professor Bull has announced that the Chemical Engineering Department will move into its new building during the summer of 1959. This new facility will provide expanded space for research, instruction and offices. In addition to general laboratory space, special laboratories will be provided for instrumentation, corrosion, electrochemical processes, and nuclear chemical engineering. U. S. Patent Number 2,848,396 covering an electrochemical method for preparing boron from fused salt mixtures has been issued to Professor Nelson E. Murphy and Dr. Richard S. Tinsley, now with Allied Chemical and Dye Corporation, Hopewell, Virginia.

Mr. Tilton E. Shelburne of the Virginia Council for Highway Investigation and Research, attended the annual meeting of the Highway Research Board in Washington in January. He presented two papers: "Resume of the First International Skid Prevention Conference" and "Review of Laboratory and Field Methods of Measuring Road Surface Friction." As a director from District Six of the American Society of Civil Engineers, Mr. Shelburne attended the annual meeting of the Pittsburgh Section in January. In February he traveled to Los Angeles to attend the meeting of the National Board of Directors of the ASCE.

Dean Lawrence R. Quarles of the School of Engineering, University of Virginia, attended the meeting of the American Nuclear Society in Detroit in December. He is a member of the Board of Directors and is Chairman of the Education Committee. Dr. Orville R. Harris of the Electrical Engineering Department, University of Virginia, has been elected Vice-Chairman of the Virginia Section, Institute of Radio Engineers.

Professors Otis L. Updike and Robert M. Hubbard of the Chemical Engineering Department, University of Virginia, attended the annual meeting of the American Institute of Chemical Engineers in Cincinnati in December. Dr. Updike presented a paper "The Laboratory Period in the Process Control Course." Dr. Updike has been awarded a National Science Foundation Science Faculty Fellowship for the academic year 1959-1960. He will study at California Institute of Technology. Professor Hubbard has been elected Vice-Chairman of the Central Virginia Section of the American Institute of Chemical Engineers.

— Robert M. Hubbard

GEOLOGY

Dr. Edgar W. Spencer has been named Associate Professor of Geology and Chairman of the Department at Washington and Lee University.

The Washington and Lee faculty will be increased to three members in 1960. The present faculty has added to the geology curriculum courses in paleontology, stratigraphy and sedimentation, field methods, and basic geological concepts and has adopted a new set of major requirements for geology majors.

— Bruce W. Nelson

PSYCHOLOGY

A recent addition to the Psychology Department, College of William and Mary is E. Rae Harcum, Assistant Professor. Dr. Harcum, whose current field of interest is in visual perception, earned his B. S. at William and Mary, 1950; M. A. at Johns Hopkins, 1952; Ph.D. at University of Michigan, 1955. He is taking the place of John K. Bare who accepted the chairmanship of Psychology Department at Carleton College. Charles R. Hayward of Harvard College and Brown University has also joined the staff. Mr. Hayward is interested in information theory and Skinnerian behaviorism.

Frank A. Geldard chaired a symposium on "The Human As a Measuring Instrument" at the AAAS meetings in Washington on December 28. Professor Geldard was elected Chairman of Section I (Psychology) and was also elected Vice-President of the AAAS.

Frank W. Finger participated in the Miami Conference on Graduate Education in Psychology, attended by 120 psychologists of various affiliations, from November 29 to December 7. Among the noteworthy viewpoints aired at the conference was the following: An attempt to minimize the distinction between science and profession, stressing that all psychologists should have a primary orientation toward investigation with a secondary interest in service. Since it is impossible to anticipate precisely the directions in which Psychology will develop, the preeminent goal of graduate education must be to foster flexibility and continuing growth in the individual. General principles might be emphasized more than specialized techniques, leaving the latter to post-doctoral experience; in any case, graduate departments are to be encouraged to experiment freely, albeit responsibly, with a variety of programs. The demand for psychological services will exceed the supply available at the Ph.D. level, so more attention ought to be given to the problems of training and

utilization of non-doctoral personnel. In order to attract a fair share of the manpower pool into Psychology, it seems desirable to introduce the concept of Psychology as a research discipline into the secondary school curriculum, and it is imperative that positive steps be taken to invigorate the teaching of Psychology at the college level.

John F. Hurley announces that the staff of School Psychologists of Fairfax County has completed the first year of a study "Comparative Effectiveness of Four Basal Reading Series" in which the primary reading programs of four publishers were compared on equated groups under controlled conditions. This work, which will continue for another year, is part of a larger project in which the series of six additional publishers is being evaluated. The staff, which includes Robert Lanagan, Gloria McDowell, Catherine Murphy, and Richard Schillo, have also made a comparative study of two achievement tests, the California and the Stanford, and have conducted a controlled evaluation of a half-day versus a full-day program for first grade children.

John F. Hahn read an invited paper, "Communicating Via The Skin" at the meetings of the Speech Association of America in Chicago on December 29.

Reuben S. Horlock, formerly Chief Clinical Psychologist, Audiology and Speech Center, Walter Reed Army Hospital, has been appointed Chief, Psychological Services Center, Department of Corrections, District of Columbia. He will be responsible for designing, developing and administering a psychological treatment and research program for a selected inmate population at the District of Columbia Reformatory.

Antania Bell Morgan delivered a paper at the AAAS meetings in Washington in December on "Critical Factors in the Acceleration of Gifted Children: A Follow-up Study."

The Division of Behavioral Science, Department of Neurology and Psychiatry, University of Virginia School of Medicine announces its first Annual Symposium, "Experimental Foundations of Clinical Psychology," to be held at Charlottesville, Virginia, April 1 and 2, 1959. The members of the Symposium are Janet A. Taylor, Northwestern University, Robert B. Malmo, McGill University, Murray Sidman, Walter Reed Army Institute of Research, Irwin A. Berg, Louisiana State University, Jack A. Vernon, Princeton University, and John H. Weakland, Veterans Administration Hospital, Palo Alto, California. The Symposium will be under the chairmanship of Arthur J. Bachrach, University of Virginia. Information pertaining to attendance may be obtained by writing to Mrs. Katherine Tiffany, Secretary, Division of Behavioral Science, University of Virginia School of Medicine, Charlottesville, Virginia.

A workshop in "Play-Group Therapy" will be conducted by Haim G. Ginott, psychologist from the Child Guidance Clinic in Jacksonville, Florida, on April 9-12 in Richmond under the sponsorship of the State Department of Mental Hygiene and Hospitals.

— Cyril R. Mill

CURRENT ACADEMIC PSYCHOLOGICAL RESEARCH IN VIRGINIA ON THEORETICAL AND APPLIED ISSUES

The geographical and institutional section of the *American Psychological Association 1958 Directory* lists some 70 psychologists participating in the activities of 20 colleges and universities throughout Virginia. The training of these persons was such that 43 of them hold the Ph.D. degree, conferred in years ranging from 1918-1957, with modal date being 1952. It may be inferred, then, that those awarded these degrees are a relatively young group of scientists with the pleasant addition of a few older heads. Of the total population, 18 hold the Master's degree. The remainder of the population consists of doctorates in education, largely, and law; three persons carry the Bachelor's degree as their highest earned diploma and one listed no degree. Virginia's psychologists are seen generally to be well qualified to do research work.

In order to ascertain the nature of psychological research in progress or in preparation, letters were mailed to each of the 70 psychologists. They were requested to send an abstract of each research project familiar to them, as well as the names of the principal investigators. The inclusion of some words regarding the theoretical or practical value of the project as well as the research design, was encouraged. After the lapse of a month a second and less demanding letter was addressed to all who had not yet responded. In this way replies were received from 33 psychologists representing 17 colleges and universities. Ten of the respondents indicated they were neither engaged in research, nor were they contemplating any. Six of these people held Master's degrees, three had doctorates in philosophy, and one listed no degree. Fortunately, many of those answering included information regarding the research projects of colleagues on the original list. Hence, information arriving in time for inclusion in the present report represented the research efforts of 61 accredited psychologists in 17 of the Old Dominion's academic institutions.

Psychological research may be roughly divided into three parts, clinical, theoretical, and applied. The present paper deals only with what the writer considered to be theoretical or applied experiments. Although clinical findings are not included in this report, it may be interesting to note that petulant correspondence was received exclusively

from those mostly engaged in theoretical investigations. Thus, the clinicians submitted their summaries with bland covering letters. Several of the theoreticians, however, responded that they did not have time to comply fully with the request. One offered "a program of college administration that is quite demanding," another noted that the difficulties of an adequate response were increased "by uncertain definition of 'research project.'" It was the experimentalists too who presupposed sapience in the present writer. For example, one brief but detailed report, involving several years of work, a dozen or so papers, and a brace of investigators, concluded by stating, "Of course, you are familiar with their general objectives . . ."

The general objectives of ongoing and recent experimental, psychological research in academic Virginia are presented herewith.

LEARNING STUDIES: REINFORCEMENTS

The first of a series of experimental studies in the area of automation of learning is shortly to be completed by Diehl and Kent at Bridgewater College under a grant from the Virginia Academy of Science. This investigation is concerned with an examination of the relative effectiveness of learning nonsense syllables by machine presentation using various methods such as paired associates, anticipation, multiple choice, and written recitation. Depending upon the outcome of the first experiment on the effects of immediate reinforcement on rote memorization at the college level, later studies on foreign languages, organic chemistry, and biology will be undertaken.

Woods is investigating the effects of motivation and probability of reward on two-choice learning at Hollins College. Three experimental conditions involve motivation in the form of an aversive auditory stimulus, correction and noncorrection procedure, and a schedule of contingent reward. When the acquisition data were analyzed in the context of Estes' statistical learning theory, the main effect was found to be due to the probability of reward. A report of the experiment has been accepted for publication in the *Journal of Experimental Psychology*. Another manuscript soon to appear in that journal presents the relationship between probability difference and learning rate in a contingent partial reinforcement. In that experiment Woods found rate of learning to be directly related to probability difference.

Ogdon and Lebo, of the Richmond Professional Institute, have completed an interesting study of reward involving throwing darts at a genuine British pub dart board. It was their hypothesis, based on the goal-gradient theory, that more force would be exerted on dart throws

when subject had the opportunity to triple their raw score. Although experimenters and subjects alike enjoyed the experience, analysis of the graphic records has failed to support the hypothesis.

A variation of the effect of discrimination training conditions on secondary reinforcement is being examined experimentally at Hollins College by McGuigan.

Research aiming in the direction of establishing a more meaningful concept of motivation is being conducted by Finger and Reid at the University of Virginia. As they have proceeded in their study of patterns of ingestion in the rat, they have emphasized specific problems, such as: the interaction of eating and drinking, the physiological basis of thirst, the development of additional measures of biological drive, and the role of reinforcement upon general activity. Their work has received partial support by grants from the National Science Foundation and some results have been presented at professional meetings and in the *Journal of Comparative and Physiological Psychology* as well. Their most recent publication in that journal was entitled, "The Effect of Reinforcement Upon Activity During Cyclic Food Deprivation."

OTHER LEARNING STUDIES

A project is presently underway at the University of Virginia to extend a recent study of paired-associates learning which purported to show that associations are formed in one trial rather than by gaining strength gradually. Battig is scaling nonsense syllable pairs for ease of learning in order to eliminate one variable contaminating the earlier procedure. Several other refinements of procedure and controls should provide a more rigorous test of the hypothesis. If it receives substantiation it will have tremendous importance with respect to conceptualization of the learning process.

The influence of early experience on later behavior has been of interest to psychologists for some time. Studies of the effect of early environmental experience on intelligence as measured in an animal's maze solving ability has resulted in provocative experiments. Woods investigated the effects of subsequent free environmental experience on rats who were inferior problem solvers because of early, restricted environmental experience. Early environmental restriction was found to be related to maze learning deficiency. However, the effects of early sensory and motor deprivation can be markedly reduced by later exposure to an enriched environment.

McGuigan is experimenting with a variation of whole and part meth-

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ods of learning, the effect of delay of knowledge of results before and after a response, the effect of delay, precision and schedule of knowledge of results on performance, and the interfering effect of motor activity on knowledge of results.

STUDIES IN THEORY AND DESIGN

Arising from McGuigan's empirical interest in whole and part methods is a paper entitled, "An Explanation of Whole-Part Learning in Terms of Hullian Theory." Similar considerations of his are, "The Delay of Knowledge of Results — A Problem in Design," and a criterion for choosing between matched and randomized group designs.

In a study soon to appear in *Psychological Reports*, it is shown that presentation of data in the form of cumulative response curves, in the manner of Skinner, is subject to the possibility of serious misinterpretation. Battig asked subjects to compare pairs of curves representing the same two sets of data plotted both cumulatively and non-cumulatively. He found the cumulative pair was judged consistently to be more alike in shape and farther apart in position or location on the graph. Cumulative curves, therefore, should not be used for the communication and analysis of experimental results.

STUDIES OF DECISION MAKING

Henneman, Reid, and Lloyd, as well as several graduate students, all of the University of Virginia, have research in progress on decision making in complex situations. Under a contract with the Surgeon General of the Army, laboratory experiments are being conducted on behavior believed to be involved in a variety of military situations. Experiments are being carried on to determine the efficiency of decisions in complex task situations with varying kinds and degrees of sequential dependency among successive events, to determine whether variables influencing behavior in a two-choice situation are related in a similar manner to verbal responses that differ in complexity and have been specified in different ways, to discover the influence of irrelevant information on the discrimination of complex visual stimuli, to investigate variables influencing the identification of ambiguous (distorted) visual stimuli, and lastly, an experimental analysis of the variables determining the efficiency of short-term memory for sequentially occurring events marked by heterogeneity, i.e., the interpolation of unlike categories of information.

Bachrach, Banghart, and Pattishall have also been conducting experiments in decision making at the University of Virginia School of Medicine. Their research project consists of a number of parallel experiments under

a contract from the Office of Naval Research. The experiments are concerned with: an investigation of pre-problem set and group pressure on decision making; group structure, anxiety, and efficiency in problem solving; operant conditioning and group-leader interaction; and an analysis of the linguistic structure of verbalization during group problem solving. A report on one aspect of these experiments has been presented at a meeting of the Southern Psychiatric Association

PHYSIOLOGICAL STUDIES

Bachrach, Gibson, and Johns have noted that pigeons may remain active for 1500 hours with minimal breaks. Their experiment seeks to determine whether the sleep patterns of pigeons are markedly different from those of other animals, or if pigeons do not sleep. By correlating electroencephalographic patterns in pigeons with a cumulative behavior record they hope to arrive at an understanding of the periodicity of sleeping and waking cycles of the pigeon.

Hawks is investigating cutaneous electrical intensity discrimination at the University of Virginia. Comparison with results in experiments involving audition and mechanical vibration has been facilitated. Another of his aims is determining the number of intensity levels which may be used as cues for signaling purposes. A dissertation furnishing complete details of these investigations is now being prepared.

Two physiological studies concerned with vision are anticipated by Kent. In one of these studies the International Commission of Illumination's tristimulus values of negative afterimages will be computed. The second investigation will examine the adaptation of the eye to various colors. A pilot study indicated that chromatic adaptation may be a function of the method by which it is determined. The equality of brightness technique demonstrated chromatic adaptation while it was not shown by flicker photometry. Such data will have potential value in color vision theory.

STUDIES OF CONDITIONING

Guthrie, of the College of William and Mary, has been carrying out research on the conditioned and unconditioned stimulus time interval using avoidance training on white rats. Dovel and Kent are attempting to obtain higher order conditioning of the human response. Such conditioning was reported in 1935. Since then, however, 12 published experiments have indicated a failure to observe higher order pupillary conditioning. Three years ago a student project at Bridgewater successfully demonstrated the conditioning but lacked satisfactory quantitative measurement.

The present study is using automatically timed high speed photography to record pupil change. It is being performed under a Virginia Academy of Science Research Grant.

FUTURE RESEARCH TRENDS

By far the greatest number of theoretical investigations treated in the present paper are aspects of learning theory. Even the majority of studies in theory and design correspond closely to interests in learning theory. In view of the importance and prominence of this theory it may be expected that such studies will continue to dominate the field of theoretical academic research. Learning theory originated in the university and, with few exceptions, such research has continued to flow from academic institutions.

Such theoretical unity in research seems healthful, for it suggests that most of the investigations are centered around ideas rather than individuals. Thus, theories are being systematically explored rather than the shifting research interests of individuals pursued. This welding to a supporting framework is also apparent in the applied studies.

In brief, the present writer believes that theoretical and applied research in the departments of psychology in Virginia's colleges and universities is in a healthy and flourishing state, despite the somewhat disparaging comments which were made earlier upon the correspondence of those engaged in such investigations.

— Dell Lebo

STATISTICS

Seven members of the Department of Statistics, Virginia Polytechnic Institute, attended the Christmas meetings of the American Statistical Association and the Biometric Society, in Chicago. They were Boyd Harshbarger, president of the Biometric Society, Ralph A. Bradley, H. A. David, David Hurst, Rolf Bargmann, William Glenn, and C. W. Clunies-Ross.

Under a grant from the Ford Foundation, the Department of Statistics, Virginia Polytechnic Institute, is completing the indexing of the *Journal of the American Statistical Association*, Volumes 35 through 50.

Tom Sparks has completed his Ph.D. requirements and has taken a position with DuPont in Wilmington, Delaware. His dissertation was "Significant Tests in Experiments Involving Paired Comparisons."

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Mr. R. J. Taylor joined the Department of Statistics, Virginia Polytechnic Institute, as an assistant professor on January 1, 1959. Mr. Taylor received his B. S. degree from Virginia Polytechnic Institute. He has been working at the National Institute of Health and has obtained a leave of absence to permit him to work on a contract involving reliability.

Charles Quesenberry completed requirements for the Master of Science degree in statistics at Virginia Polytechnic Institute and is currently working on his Ph. D. degree in Statistics.

N. L. Enrick's book "Quality Control," published by The Industrial Press, New York, is scheduled to appear in their edition about the middle of March, 1959. This book deals with the application of statistical methods of control in industry, with examples drawn from metalworking, chemical and textile processing.

— Clyde Y. Kramer

Virginia Academy of Science

Program

OF THE

Thirty-Seventh Annual Meeting

AT THE UNIVERSITY OF VIRGINIA

CHARLOTTESVILLE, VIRGINIA



May 6, 7, 8, 9, 1959

HOST TO MEETING

The University of Virginia

Virginia Academy of Science

OFFICERS

John C. Forbes, *President*
William M. Hinton, *President-Elect*
Paul M. Patterson, *Secretary*
Foley F. Smith, *Treasurer*
William B. Wartman, *Assistant Secretary-Treasurer*

COUNCIL

Elected Members

Harry G. M. Jopson (1959)	Thomas C. Gilmer (1961)
Thelma C. Heatwole (1960)	Horton H. Hobbs, Jr. (1962)
Ralph A. Bradley (1963)	

Ex-Officio Members

Walter S. Flory, Jr. (1959)	George W. Jeffers
Edward S. Harlow (1960)	Ralph A. Bradley
William G. Guy (1961)	Robert T. Brumfield
Charles F. Lane	

LOCAL COMMITTEE ON ARRANGEMENTS

General Chairman: Dr. S. P. Maroney, Jr., Department of Biology
University of Virginia, Charlottesville, Virginia.

Housing: Dr. Jacques Rappaport, *Chairman*,

Junior Academy: Dr. Edward Victor, *Chairman*.

Registration: Dr. Richard McKinsey, *Chairman*.

Public Information: Dr. Kenneth Lloyd, *Chairman*.

Commercial Exhibits: Dr. Bartholomeus Van't Riet, *Chairman*.

Meeting Rooms and Equipment: Dr. Starling Reid, *Chairman*

HOST TO MEETING

THE UNIVERSITY OF VIRGINIA

General Program Of The 37th Annual Meeting

EXHIBITORS. SECOND FLOOR, NEWCOMB HALL

WEDNESDAY, MAY 6

5:00 P.M. to 10:00 P.M. — Registration for Junior Academy Members and Participants in the Science Talent Search. Gymnasium.

5:00 P.M. to 10:00 P.M. — Arrangement of Exhibits. Gymnasium.

THURSDAY, MAY 7

8:00 A.M. to 10:00 P.M. — Registration. South Lobby, Newcomb Hall.

9:00 A.M.—Meeting of Science Exhibit Judges. Gymnasium.

Meeting of Science Talent Search Judges. 4C, Newcomb Hall.

9:30 A.M.—Meeting of Chairmen, Exhibitors, and Science Talent Search Participants. Gymnasium.

10:00 A.M. to 12:15 P.M. and 1:15 to 4:00 P.M. — Finalists of Talent Search Meet with Chairmen and Interviewers. Newcomb Hall 4A, 4B, 4C Board Room, Conference Room.

10:00 A.M. to 12:15 P.M. and 1:15 to 4:00 P.M. — Judging of Science Exhibit Contest. (Encouragement of Juniors at their Exhibits.) Gymnasium.

1:00 P.M. Section of Science Teachers. Peabody 104

2:00 P.M.—Meeting of the Council. South Meeting Room, Newcomb Hall.

4:30 P.M.—Meeting of Section Officers. 4C, Newcomb Hall.

4:30 P.M.—Meeting of Section Editors. Conference Room, Newcomb Hall.

5:30 P.M.—Meeting of Junior Academy of Science Committee, Board Room, Newcomb Hall.

8:00 P.M.—Annual Academy Conference. 11 Monroe Hall.

FRIDAY, MAY 8

8:30 A.M. to 10:00 P.M. — Registration. South Lobby, Newcomb Hall.

9:00 A.M.—Section Meetings. See the detailed section programs for the time schedule of papers.

Agricultural Science — Biology 3.

Astronomy, Mathematics, and Physics — Physics, Large Auditorium.

Bacteriology — 4A, Newcomb Hall.

Biology — South Meeting Room, Newcomb Hall.

Chemistry — Peabody 106

Education — Peabody 108

Engineering — Physics, Small Auditorium.

Geology — Peabody 1.

Medical Science — Conference Room, Newcomb Hall.

Psychology — 4C Newcomb Hall.

Statistics — 4B Newcomb Hall.

12:00 Noon to 2:00 P.M. — Virginia Junior Academy of Science Assembly. Ballroom, Newcomb Hall. (See Program of Junior Academy.)

12:15 P.M. to 1:15 P.M. — Recess for Luncheon.

1:30 P.M.—Section Meetings.

5:00 P.M. to 6:00 P.M. — Tea, University of Virginia host, Ballroom, Newcomb Hall.

6:00 P.M. to 8:00 P.M. — Recess for Dinner.

8:00 P.M.—Virginia Academy of Science Assembly. Cabell Hall Auditorium.

Short Business Meeting. Election of Officers.

Presentation of the J. Shelton Horsley Research Award.

Guest Speaker: S. I. Gale: *American Cyanamid Company*

Subject: "Chemistry on a Cosmic Scale"

The general public is invited to attend.

SATURDAY, MAY 9

9:00 A.M.—Section Meetings.

10:00 A.M.—Meeting of the Council of the Academy. 4A Newcomb Hall.

Program Of The Virginia Junior Academy Of Science

WEDNESDAY, MAY 6

5:00 P.M. to 10:00 P.M. — Registration for Junior Academy Members and Participants in the Science Talent Search. Gymnasium.

5:00 P.M. to 10:00 P.M. — Arrangement of Exhibits. Gymnasium.

THURSDAY, MAY 7

8:00 A.M. to 10:00 P.M. — Registration. Gymnasium.

9:00 A.M. to 9:30 A.M. — Meeting of Science Exhibit Judges. Gymnasium. Meeting of Talent Search Judges. 4C Newcomb Hall.

9:30 A.M. to 10:00 A.M. — Meeting of Chairmen, Exhibitors, and Science Talent Search Participants. Gymnasium.

10:00 A.M. to 12:15 P.M. — and 1:15 P.M. to 3:00 P.M. — Finalists of Talent Search meet with Chairmen and Interviewers. Newcomb Hall 4A, 4B, 4C, Board Room, Conference Room.

10:00 A.M. to 12:15 P.M. — and 1:15 P.M. to 3:00 P.M. — Judging of Science Exhibit Contest. Gymnasium.

4:00 P.M.—Business Meeting of Virginia Junior Academy of Science. Ballroom, Newcomb Hall.

7:30 P.M.—Discussion Hour: Junior Academy Members and Invited Scientists.

FRIDAY, MAY 8

9:00 A.M.—Participation in the Senior Academy Section Meetings.

12:00 Noon to 2:00 P.M. — Virginia Academy of Science Assembly and Awards Hour. Ballroom, Newcomb Hall.

Guest Speaker: R. N. DuPuis; *Phillip-Morris, Inc.*

Section Of Agricultural Science

S. S. Obenshain, *Chairman*

Maurice B. Rowe, III, *Vice-Chairman*

Wm. H. Brittingham, *Secretary*

Carl W. Allen, *Section Editor*

FRIDAY, MAY 8, — 8:30 A.M. — BIOLOGY 3

8:30 Call to order by Chairman. Announcements and Committee Appointments.

1. 8:45 A 26-Year Weather Summary at Holland, Virginia.
D. L. Hallock; *Tidewater Research Station, Virginia Agricultural Experiment Station*
2. 9:00 Some New Cultural Techniques in Strawberry Production in Eastern Virginia.
M. M. Parker; *Virginia Truck Experiment Station, Norfolk*
3. 9:15 The Development of F₁ Spinach Hybrids Adapted to Eastern Virginia.
E. A. Borchers; *Virginia Truck Experiment Station, Norfolk*
4. 9:30 Some New Aspects of Potato Insect Investigations in Southeastern Virginia.
R. N. Hofmaster; *Eastern Shore Branch, Virginia Truck Experiment Station, Painter*
5. 9:45 *Guest Speaker:* A. C. Orvedal, Chief, *World Soil Map, Soil Survey Investigations, USDA*
Subject: Engineering Use of Pedological Soils Information.
- 10:15 Recess
6. 10:30 Rates and Types of Ground Limestone for Alfalfa.
George D. Jones and W. W. Moschler; *Virginia Agricultural Experiment Station.*
7. 10:45 2, 3, 5 Triphenyl Tetrazolium Chloride as a Quick Test in determining Viability of small Grain seeds.
T. G. Copeland, Jr., and C. F. Bruce; *Division of Plant Industry, Virginia Department of Agriculture*

8. 11:00 *Guest Speaker: W. L. Hill, Fertilizer Materials Section, Soil and Water Conservation Research Division*
Subject: Trends in Fertilizer Technology.
9. 11:30 *Woodchucks: A Major Agricultural Pest in Virginia.*
John C. Jones; Fish and Wildlife Service, U. S. Department of Interior
- 11:50 Adjourn for Lunch
10. 1:15 *Nutritional Status of Rural Haitians.*
K. W. King and G. L. Brinkman; Virginia Agricultural Experiment Station
11. 1:30 *Purification of a Growth Factor found in Meat Meal.*
Paul Lepore and C. J. Ackerman; Virginia Agricultural Experiment Station
12. 1:45 *The Influence of Dominance Rank on Sexual Activity of Chickens.*
P. B. Siegal; Virginia Agricultural Experiment Station
13. 2:00 *The Use of equine Gonadotrophins in increasing reproductive Performance of Ewes.*
G. H. Kiracofe and J. W. Gossett; Virginia Agricultural Experiment Station
14. 2:15 *The Effect of Certain Feed Additives and Feed Preparations for Fattening Feeder Lambs.*
H. A. Hopkins, J. P. Fontenot, W. M. Mestanza, and J. S. Copenhagen; Virginia Agricultural Experiment Station
15. 2:30 *Cell Divisions in Wool Follicles and the Chromatin Reaction in the Skin of Sheep throughout the Seasons.*
Lubow A. Margolena; Animal Husbandry Department, U. S. Department of Agriculture, Beltsville, Md.
- 2:45 Recess
16. 3:00 *Use of Electronic Data Computing Methods to analyze the Basic Survey of Virginia Dairying.*
Robert F. Hutcheson; Division of Markets, Virginia Department of Agriculture
17. 3:15 *The Economics of feeding Grain to Milking Cows on Pasture.*
W. A. Hardinsson and G. C. Graf; Virginia Agricultural Experiment Station

18. 3:30 Progress Report on Research on Dwarfism in Beef Cattle.
Thomas J. Marlowe; *Virginia Agricultural Experiment Station*
 19. 3:45 Preliminary Investigation of the Fermentation of Uniformly
Labelled C¹⁴-glucose by Rumen Microorganisms.
J. H. Newman and W. E. C. Moore; *Virginia Agricultural
Experiment Station*
 20. 4:00 The Effects of Implanting Different Levels of Stilbestrol in
Grazing Beef Steers.
J. P. Fontenot, R. F. Kelly, and J. A. Gaines; *Virginia Agri-
cultural Experiment Station*
 21. 4:15 Effects of Selected Physical and Economic Variables on Prices
of Calves in Virginia Feeder Calf Sales.
K. C. Williamson, R. C. Carter, G. W. Litton, J. D. Johnson,
and G. A. Gaines; *Virginia Agricultural Experiment Station*
- 4:30 Business Session

Section Of Astronomy, Mathematics, And Physics

J. J. Taylor, *Chairman*

Robert C. Yates, *Secretary*

Irving G. Foster, *Section Editor*

FRIDAY, MAY 8, 1959 — 9:00 A.M. LARGE AUDITORIUM, PHYSICS

9:00 Announcements and Remarks by the Chairman.

1. 9:10 Equilibrium Ultracentrifuge.
C. E. Williams, R. D. Boyle, and J. W. Beams; *University
of Virginia*
2. 9:25 Yield of Fast Photoneutrons from Heavy Elements.
G. C. Reinhardt and L. B. Aull; *University of Virginia*
3. 9:40 Photoproton Yields from Light Elements.
D. C. Worth and G. Haste; *University of Virginia*

4. 9:55 Angular Distribution of 14-Mev Neutrons Scattered by Light Elements.
B. C. Groseclose, R. F. Stetson, and W. W. Walker; *University of Virginia*
5. 10:10 Demonstrations of Parity Conservation.
F. L. Hereford and J. S. Plaskett; *University of Virginia*
6. 10:30 A Precision 0 to 20 amp Magnet Current Control.
M. A. Chramiec and C. D. Bond; *Virginia Polytechnic Institute*
7. 10:45 A Water-Moderated Natural Uranium Sub-Critical Reactor.
T. H. Row and Andrew Robeson; *Virginia Polytechnic Institute*
8. 11:00 Observation of the Decay of Absorbed Barium-133 in the Field Emission Microscope.
William C. Saunder; *Virginia Military Institute*
9. 11:15 Divisibility Testing.
Herta T. Freitag; *Hollins College*, and Arthur H. Freitag; *Jefferson High School*
10. 11:35 Some Aspects of Terminal Ballistics.
Robert L. Kernell; *College of William and Mary*
- 11:50 Business meeting
- 12:15-1:15 Luncheon Recess.
11. 1:20 Curvatures of $r^n = \cos n\theta$.
Robert C. Yates; *College of William and Mary*
12. 1:40 Probability for High School Students.
Beatrice A. Harrington; *Maggie L. Walker High School*
13. 1:55 A Laboratory for Liberal Arts Physics.
J. L. McKnight; *College of William and Mary*
14. 2:15 Historical and Philosophical Experiments in Elementary Physics.
Richard H. Prosl; *College of William and Mary*
15. 2:30 The Junior Instructorship Program at William and Mary.
R. C. Yates, Garrett Etgen, and Richard H. Prosl; *College of William and Mary*
16. 2:50 Experiments for Advanced Undergraduates.
W. D. Whitehead; *University of Virginia*
17. 3:05 An Apparatus for the Measurement of the Range of Alpha Particles in Air.

J. W. Little; *College of William and Mary*

18. 3:20 An Intermediate Laboratory Experiment on Rutherford Scattering of Alpha Particles.
E. T. Gerry; *College of William and Mary*
19. 3:30 An Analog Computer Used in Reactor Simulation.
William S. Baber and Andrew Robeson; *Virginia Polytechnic Institute*
20. 3:50 Simultaneous Photoelectric Effect of Two Electrons.
F. R. Crownfield, Jr.; *College of William and Mary*

Alternates

Unfamiliar Facts Concerning Thermoelectricity.

L. G. Hoxton; *University of Virginia*

Electrical Conduction in Magnetic Thin Films. I — Theoretical.

B. W. Sloop and A. D. Campbell; *University of Richmond*

Electrical Conduction in Magnetic Thin Films. II — Experimental.

A. D. Campbell, J. F. Garren, Jr., A. C. Hudgins, Jr., and B. W. Sloop; *University of Richmond*

Surface Deformation of Cooper Monocrystals at High Temperatures.

John M. Bailey; *University of Virginia*

SATURDAY, MAY 9, 1959 — 9:00 A.M.

21. 9:00 Motions and Absolute Magnitudes of Mira Type Stars.
H. L. Alden and V. Osvalds; *L. McCormick Observatory*
and A. Marguerite Risley; *Randolph-Macon Woman's College*
22. 9:25 Oscillation Theorems for Difference Equations.
J. S. Plaskett; *University of Virginia*
23. 9:40 Mechanical Properties of Whiskers.
M. J. Skove; *University of Virginia*
24. 9:55 Conductibility of Metallic Whiskers at Low Temperatures.
E. P. Stillwell; *University of Virginia*
25. 10:10 Piezoresistance Effect at Very High Elastic Strains in Metallic Whiskers.
H. H. Hobbs; *University of Virginia*
26. 10:25 Positron Lifetime in Water and Ice.
W. W. Walker and W. S. Walker; *University of Virginia*

- 27. 10:40 Possible Effects of Centrifugal Fields on Radioactive Lifetimes.
W. Tucker; *University of Virginia*
- 28. 10:55 Mechanical Strength of Thin Films of Metal.
H. H. Pattillo and C. J. Lowman; *University of Virginia*
- 29. 11:10 Elastic Scattering of 2 to 4 Mev Polarized Neutrons.
W. P. Bucher, W. B. Beverly, and G. C. Cobb; *University of Virginia*
- 30. 11:30 Recent High Pressure Investigations of Solidified Gases at Low Temperature.
John W. Stewart and Robert F. Patterson; *University of Virginia*
- 31. 11:50 The Surface Structure of growing Crystals.
N. Calvera; *University of Virginia*

Section Of Bacteriology

(*Virginia Branch, Society of American Bacteriologists*)

Miles Hench, *President*

Quentin Myrvik, *Vice-President*

Catherine M. Russell, *Secretary*

P. Arne Hansen, *Section Editor*

FRIDAY, MAY 8, 1959 — NEWCOMB HALL, 4A

11:00 A.M. Business Meeting

12:00 NOON Adjourn

2:00 P.M. Presentation of Scientific Papers.

2:00 P.M. The Enzymatic Formation of Arabinose-5-Phosphate.
Wesley A. Volk; *Department of Microbiology, University of Virginia School of Medicine*

2:20 P.M. A Comparative Study of Media for the Detection of Enterococci in Water.
R. Travis Hill; *State Department of Health Laboratory, Richmond*

- 2:40 P.M. *Listeria Meningitis — Is It Rare?*
H. J. Welshimer; *Department of Microbiology, Medical College of Virginia*
- 3:00 P.M. *Serum Lysozyme Levels in Rabbits undergoing a Generalized Granulomatous Reaction.*
Quentin N. Myrvik and Eva Soto Leake; *Department of Microbiology, University of Virginia School of Medicine*
- 3:20 P.M. *Reduction of Potassium Tellurite by Streptococcus bovis.*
Margaret Carlson and P. Arne Hansen; *Department of Microbiology, University of Maryland, College Park*
- 3:40 P.M. *Observations on the Effect of Carbon Dioxide on the Growth of Entamoeba histolytica.*
E. Clifford Nelson and Muriel M. Jones; *Department of Microbiology, Medical College of Virginia*

Section Of Biology

William W. Scott, *Chairman*

Jesse C. Thompson, Jr.; *Secretary*

Walter S. Flory, Jr.; *Section Editor*

FRIDAY, MAY 8 — 9:00 A.M. — SOUTH MEETING ROOM
NEWCOMB HALL

1. 9:00 *Experimental Evocation of Differentiation of Chick Melanocytes.*
Willie M. Reams, Jr. and Stuart E. Nichols, Jr.; *Medical College of Virginia*
2. 9:15 *Serosal Melanocytes in the Pet Mouse.*
Stuart E. Nichols, Jr. and Willie M. Reams, Jr.; *Medical College of Virginia*
3. 9:30 *Techniques with a Microrespirometer.*
Jack D. Burke; *University of Richmond*
4. 9:45 *The Effect of Propylthiouracil on Gross Weights of Thyroid Ovaries, and Adrenals of the Albino Rat.*
Iris B. Hadden and W. L. Mengebier; *Madison College.*
5. 10:00 *Tissue Ergothioneine.*
Kamal Yackzan; *University of Richmond*

6. 10:15 A Comparative Study of Vertebrate Embryonic Serum Proteins.
Edwin M. Weller; *Randolph-Macon Woman's College*
7. 10:30 Action of Iproniazid on *Tetrahymena pyriformis*.
Joseph Krezanoski; *Medical College of Virginia*
8. 10:45 Studies on the Control of Growth in Timothy Roots.
Robert T. Brumfield; *Longwood College and Oak Ridge National Laboratory*
9. 11:00 A Comparison of Initial Effects from Gamma Radiation upon
Some Gymnosperms and Angiosperms.
W. S. Flory and W. Ralph Singleton; *The Blandy Experimental Farm, University of Virginia*.
10. 11:15 Embryological Evidence for the Relationship of Aquifoliaceae
to Celastraceae.
J. M. Herr, Jr.; *Pfeiffer College*
11. 11:30 Ground Vegetation Patterns of the Spruce-fir Area of the
Great Smoky Mountains National Park
Dorothy L. Crandall; *Randolph-Macon Woman's College*
12. 11:45 The Controversial Sex-bivalent in the Golden Hamster.
Lyman R. Emmons; *University of Virginia*
13. 12:00 The Chromosomes of Several *Zephyranthes* Species from the
West Indies.
W. S. Flory, Jr.; *The Blandy Experimental Farm, University of Virginia*
14. 12:15 A Study of Phylogeny and of Karyotype Evolution in *Lycoris*.
Smritinoy Bose; *The Blandy Experimental Farm, University of Virginia*
15. 12:30 Experimental Infections of Chick Embryos with *Tetrahymena pyriformis*.
Jesse C. Thompson, Jr., Lynne Santy, and Valer Clark; *Hollins College*
- 12:45 Section Business Meeting.
16. 2:00 Invitation Paper. Plant Migrations in Mid-Appalachian Region.
E. L. Core; *West Virginia University*
17. 2:45 Virginia Flora.
A. B. Massey; *Virginia Polytechnic Institute*
18. 3:00 Notes on the Helminths of Mammals in the Mountain Lake

Region — The Helminths of Rabbits.

Harry L. Holloway; *Roanoke College*

19. 3:15 Evaluation of Rabbit Management Methods by Live Trapping.
Donald K. Fortenbery; *Virginia Polytechnic Institute*
20. 3:30 Techniques Involved in the Use of Chemicals for Establishing
Wildlife Clearings.
Harold A. Trumbo; *Virginia Polytechnic Institute*
21. 3:45 Effect of Forestry Practices and Wildlife Management on
Abundance and Distribution of Deer.
John H. Quillen, Jr.; *Virginia Polytechnic Institute*
22. 4:00 Incidence and Causes of Tularemia in Humans in Virginia.
Burd S. McGinnes; *Virginia Cooperative Wildlife Research
Unit, Virginia Polytechnic Institute*
23. 4:15 The Effect of Blackbirds upon Agriculture in Southeastern
Virginia.
Thomas C. Crebbs, Jr.; *Virginia Polytechnic Institute*
24. 4:30 The Stomach Contents of *Rana catesbeiana* Shaw as Corre-
lated with Different Pond Environments.
Garnett R. Brooks, Jr.; *University of Richmond*
25. 4:45 The Food of the Chain Pickerel *Esox niger* LeSueur in
Tuckahoe Creek.
David A. Felmer; *University of Richmond*
26. 5:00 Respiration and Hemolysis of Ultraviolet Irradiated Frog
Erythrocytes.
Lewis Harvie and S. P. Maroney, Jr.; *University of Virginia*
27. 5:10 Observations on the Biology of *Pelomyxa palustris* Greef
Collected under polysaporbic Conditions.
Daniel H. Stern; *University of Richmond*
28. 5:20 Studies on Tardigrades from Virginia.
G. T. Riggan, Jr.; *Virginia Polytechnic Institute*

Section Of Chemistry

Frank A. Vingiello, *Chairman*

Mearl A. Kise, *Secretary*

Mearl A. Kise, *Section Editor*

FRIDAY, MAY 8 — 9:00 A.M. — PEABODY 106

9:00 Announcements; Introductory Remarks

1. 9:15 The Effect of Foreign Metals on the Corrosion of Titanium in Boiling 2M Hydrochloric Acid.
W. Roger Buck, III, Billy Sloope and Henry Leidheiser, Jr.; *Virginia Institute for Scientific Research*
2. 9:30 Oxidative Studies of Dipyrldylamines.
Robert N. Lawhorn, Ertle Thompson, Oscar Rodig and James W. Cole, Jr.; *Department of Chemistry, University of Virginia*
3. 9:45 N-Substituted L- Amino Nitriles.
L. Neelakantan; *Department of Chemistry and Pharmaceutical Chemistry, Medical College of Virginia*
4. 10:00 Quantitative Microanalysis of Alkoxy Groups.
Robert E. Bailey and Bryant Harrell; *Department of Chemistry, College of William and Mary*
5. 10:15 A Study of the Structure of Nitryl Chloride.
John C. Kotz and Richard P. Carter; *Chemistry Department, Washington and Lee University*
6. 10:30 Synthetic Homologs of L-Amino Acids and Their Derivatives as Anti-Tumor Agents.
John Andrako, J. Doyle Smith and W. H. Hartung; *Department of Chemistry and Pharmaceutical Chemistry, Medical College of Virginia*
7. 10:45 Selected Addition Complexes of Nitryl Chloride.
Richard P. Carter and John C. Kotz; *Chemistry Department, Washington and Lee University*
8. 11:00 The Infra-red Absorption of Phosphorus Compounds.
Margaret Anne Barber; *Research Department, Virginia-Carolina Chemical Corporation*

9. 11:15 Specific Centers in Palladium Catalysts.
Robert L. Beamer and Walter H. Hartung; *Department of Chemistry and Pharmaceutical Chemistry, Medical College of Virginia*
10. 11:30 Research in Cancer Chemotherapy.
John E. Yurko and Bryant Harrell; *Department of Chemistry, College of William and Mary*
- 11:45 Business Meeting
11. 1:00 Recent Electron and Optical Micrographs of a Catalyst Surface.
Allan T. Gwathmey; *Cobb Chemical Laboratory, Department of Chemistry*; Shaukt Azim; *Department of Chemical Engineering, University of Virginia*
12. 1:15 Electron Microscope Observations on the Decomposition of Molybdenum Trioxide and Cuprous Oxide.
Kenneth R. Lawless; *Cobb Chemical Laboratory, Department of Chemistry, University of Virginia*
13. 1:30 Carotenoid Pigments of Aged Burley Tobacco.
H. E. Wright, Jr., W. W. Burton and R. C. Berry, Jr.; *Department of Research and Development, The American Tobacco Company*
14. 1:45 Qualitative Elementary Analysis of Organic Compounds by a Combustion Method.
Frank Denaro and Bryant Harrell; *Department of Chemistry, College of William and Mary*
15. 2:00 A Study of the Acid Catalyzed Cleavage of 10-Cyclohexyl-1, 2-Benzanthracene.
F. A. Vingiello and T. Delia; *Chemistry Department, Virginia Polytechnic Institute*
16. 2:15 Surface Tension, Intermolecular Distance and Association Energy of a Pure Non-Polar Liquid.
Ralph G. Steinhardt, Jr.; *Department of Chemistry, Hollins College*
17. 2:30 Some Colorless Polyenes of Aged Burley Tobacco.
H. E. Wright, Jr., W. W. Burton and R. C. Berry, Jr.; *Department of Research and Development, The American Tobacco Company*
18. 2:45 Proof of Structure of 4-Hydroxy-2-methyltetrahydrothiophene 1, 1-Dioxide.

Robert C. Krug and James A. Rigney; *Department of Chemistry, Virginia Polytechnic Institute*

19. 3:00 Inhibition of the Nitrostyrene Condensation in Acetic Acid by Traces of Water.
Charles E. Bell, Jr., and Thomas I. Crowell; *Cobb Chemical Laboratory, University of Virginia*
20. 3:15 Quantitative Separation of Some Pyridine Compounds by Paper Chromatography.
Eugene Glock and T. H. Vaughan, Jr.; *Department of Research and Development, The American Tobacco Company*
21. 3:30 The Preparation of a 10-(Hydroxymethylphenyl)-1, 2-Benzanthracene.
F. A. Vingiello and C. Lewis; *Chemistry Department, Virginia Polytechnic Institute*
22. 3:45 Kinetics in a Dual Temperature System.
Thomas I. Crowell; *Cobb Chemical Laboratory, University of Virginia*
23. 4:00 An Investigation of Three Derivatives of Chromotropic Acid as Possible Colorimetric Reagents for the Simultaneous Determination of Uranium and Thorium.
H. Perry Holcomb and John H. Yoe; *Pratt Trace Analysis Laboratory, Department of Chemistry, University of Virginia*
24. 4:15 Color Reactions of 1, 4-Dihydroxyanthraquinones.
E. Guy Owens II; *Pratt Trace Analysis Laboratory, Department of Chemistry, University of Virginia*
25. 4:30 Spectrophotometric Determination of Manganese (II).
Dwight O. Miller; *Pratt Trace Analysis Laboratory, Department of Chemistry, University of Virginia*
26. 4:45 Spectrochemical Determination of Trace Amounts of Nickel in Normal Human Plasma and Red Blood Cells.
Leonel M. Paixao; *Pratt Trace Analysis Laboratory, Department of Chemistry, University of Virginia*
27. 5:00 Some Observations of Crystal Imperfections during Oxidation and Catalytic Reaction on Copper.
R. H. Kean; *Cobb Chemical Laboratory, Department of Chemistry, University of Virginia*

Education Section

Charles J. Turner, *Chairman*

George W. Kent, *Secretary*

James B. Patton, *Section Editor*

FRIDAY, MAY 8, 1959 — 9:00 A.M. — PEABODY 108

1. 9:00 The Relation between ACE Scores and Academic Success in College.
A. L. Wingo; *State Department of Education*
2. 9:15 Socio-psychological Factors in the Development of Children's Interest.
Judith Hollen; *Bridgewater College*
3. 9:30 A Study of Teacher Evaluation in College.
Donald Banks; *Bridgewater College*
4. 9:45 Where Do College Teachers Come From?
W. D. Clague; *Bridgewater College*
5. 10:00 Symposium: Relative Merits of Laboratory vs. Demonstration in the Teaching of Science.
A. L. Wingo, *Moderator*
Earl Savage, *Science Coordinator, Richmond Public Schools*
Richmond
Sydney S. Negus; *Medical College of Virginia*
Franklin D. Kiser; *Assistant Supervisor of Public Education — Science*
Richard Irby; *Leader, Physical Chemistry Section, Department of Research and Development, American Tobacco Company*
6. 10:45 Business Meeting.

Section Of Engineering

B. A. Niemeier, *Chairman*

O. R. Singleton, Jr.; *Secretary*

R. M. Hubbard, *Section Editor*

FRIDAY, MAY 8 — 9:10 A.M. — PHYSICS, SMALL AUDITORIUM

9:10 The Electrometer Measurement of Very Low Ion Densities in Gases.
Robert L. Ramsey and Robert L. Overstreet; *Department of Electrical Engineering, University of Virginia*

9:30 Research in Continuously Reinforced Concrete Pavements.
Howard Newlon, Jr.; *Virginia Council of Highway Investigation and Research, University of Virginia*

9:50 Theoretical Analysis of Torsion in Skewed Bridges
William Zuk; *Department of Civil Engineering, University of Virginia*

10:10 The Effect of Mechanical Vibration on Liquid Film Heat Transfer Coefficients.
Dennis M. Frame; *School of Engineering, University of Virginia*

10:30 Heat Transfer in a Hot Water Storage Heater
Robert M. Hubbard and Edward J. Leech; *Department of Chemical Engineering, University of Virginia*

10:50 Break

11:00 Hypersonic Stability of Three Fundamental Missile Nose Configurations.
E. B. Pritchard; *Aeronautical Engineering Department, Virginia Polytechnic Institute*

11:20 The Applicability of Sandwich Type Structures for Missile Construction.
E. B. Pritchard and J. S. Pratt; *Aeronautical Engineering Department, Virginia Polytechnic Institute*

11:40 On the Optimization of Missile Trajectories.
J. E. Eades, Jr., J. N. Perkins, and R. B. Richards; *Aeronautical Engineering Department, Virginia Polytechnic Institute*

12:00 Presentation of Engineering award at the meeting of the Junior Academy of Science

- 2:00 On the Problem of Earth Satellites.
J. B. Eades, Jr., and R. N. Bell; *Aeronautical Engineering Department, Virginia Polytechnic Institute*
- 2:20 Boundary Layer Control by Magnetoaerodynamic Techniques.
R. W. Truitt and C. M. Jackson, Jr.; *Aeronautical Engineering Department, Virginia Polytechnic Institute*
- 2:40 Effects of Compressibility in Magnetoaerodynamics.
R. W. Truitt and L. B. Callis; *Aeronautical Engineering Department, Virginia Polytechnic Institute*
- 3:00 Break
- 3:10 The Fundamentals of Gaseous Diffusion Applied to a System of Hydrogen and Carbon Dioxide.
Russell A. Primrose; *Chemical Engineering Department, Virginia Polytechnic Institute*
- 3:25 The Design Construction and Operation of a Heat Exchanger for a Moving Bed Hypersorption Process.
William A. Barkley and Stuart B. Row; *Chemical Engineering Department, Virginia Polytechnic Institute*
- 3:40 Factors Affecting Mass Transfers in a Mixer-Settler Extractor.
G. E. Brown, N. C. M. Landis, and Dr. F. W. Bull; *Chemical Engineering Department, Virginia Polytechnic Institute*
- 4:10 Electrolytic Recovery of Caustic and Acid from Pulp Waste with Ion Exchange Membranes.
E. J. Holberg and N. F. Murphy; *Chemical Engineering Department, Virginia Polytechnic Institute*
- 4:30 Engineering Exhibits
Presented by members of the Virginia Junior Academy of Science
- 5:30 Business Meeting and Election of officers

SATURDAY, MAY 9 — 9:00 A.M. — PHYSICS, SMALL AUDITORIUM

- 9:00 General Description of the University of Virginia Nuclear Reactor.
Lawrence R. Quarles; *School of Nuclear Engineering, University of Virginia*
- 9:20 Inherent Safety of the Swimming Pool Type Nuclear Reactor.
J. Lawrence Meem; *Department of Electrical Engineering, University of Virginia*
- 9:40 Hazards Analysis for the University of Virginia Nuclear Reactor.

Walter P. Walker; *Department of Nuclear Engineering, University of Virginia*

- 10:10 Shielding of the University of Virginia Nuclear Reactor.
W. Reed Johnson; *Department of Nuclear Engineering, University of Virginia*
- 10:30 Heat Transfer in the University of Virginia Nuclear Reactor.
F. Anthony Iachetta; *Department of Mechanical Engineering, University of Virginia*
- 10:50 Study of the Fission Product Activity in the Gas Stream of a Gas Cooled Nuclear Reactor.
David D. Wallace; *School of Engineering, University of Virginia*
- 11:10 An Analog for Study Temperature Control in Jacketed Chemical Reaction Vessels.
William B. Cashion; *School of Engineering, University of Virginia*
- 11:25 Fluidized Conveying of Solids.
Elmer F. Zurn; *School of Engineering, University of Virginia*
- 11:40 Volumetric Heat Transfer Coefficient in a Parallel-flow Spray Dryer.
Everett L. Plyler; *School of Engineering, University of Virginia*
- 12:05 Equilibrium Relationships in the System CO_2 — Methylene Chloride.
John W. Eldridge and Donald S. Buell; *Department of Chemical Engineering, University of Virginia*
- 12:20 Catalytic Studies on Surfaces of Single Crystals of Nickel-Copper Alloys.
Edwin Cox, Otis L. Updike, and Allan T. Gwathmey; *Department of Chemical Engineering and Chemistry, University of Virginia*

Section Of Geology

J. T. Hack, *Chairman*

J. L. Calver, *Vice-Chairman*

R. S. Mitchell, *Secretary*

B. W. Nelson, *Section Editor*

FRIDAY, MAY 8, — 9:00 A.M. — PEABODY I

9:00 Announcements

1. 9:10 Ground-Water Resources in Western Albemarle County, Virginia
Whitman Cross, II; *University of Virginia*
2. 9:30 Garnet Deposits of the Virginia Piedmont.
C. W. Crist, Jr.; *University of Virginia*
3. 9:45 A Discussion of Iron Oxide Pseudomorphs after Pyrite Metacrysts in the Piedmont Schists of Virginia.
R. K. Peare; *University of Virginia*
4. 10:00 The Geology of the Piedmont Physiographic Provinces of Virginia as Applied to Highway Engineering.
W. T. Parrott; *Virginia Department of Highways*
5. 10:20 Highway Engineering in Virginia by Photogrammetric Methods.
F. B. Bales; *Virginia Department of Highways*.
6. 10:35 Metamorphic Features of the Black Hills Area, South Dakota.
J. A. Redden; *Virginia Polytechnic Institute*
7. 10:50 The Dore Lake Complex: A Metamorphosed Layered Complex (Chibougamau District, Quebec).
G. O. Allard; *University of Virginia*
8. 11:10 Crystallization Temperature of Anorthosite, Nelson and Amherst Counties, Virginia.
D. N. Hillhouse; *Virginia Polytechnic Institute*
9. 11:25 Cretaceous and Triassic Clay Minerals of Pamunkey River Basin.
J. R. Kreglo; *Virginia Polytechnic Institute*
10. 11:40 Some Unusual Clay Minerals from Pennsylvanian Undershales.
B. W. Nelson; *Virginia Polytechnic Institute*
- 12:00 Recess
11. 2:00 Mineral Indicators of Environment in Parts of the Coastal Plain Sediments of Maryland.
Dorothy Carroll; *United States Geological Survey*
12. 2:15 Unusual Speliothems from Walker Mountain Cave.
J. F. Quinlan; *Virginia Polytechnic Institute*
13. 2:30 Age and Fauna of Huntersville Formation, Tannersville Area, Virginia.
P. C. Ciaramella; *Virginia Polytechnic Institute*
14. 2:45 Celestite and Strontianite from Wise County, Virginia.
R. F. Pharr and R. S. Mitchell; *University of Virginia*

15. 3:00 A Description of the Concretions Found in the Millboro
Black Shales of Virginia.
C. E. Roberts and G. T. Farmer, Jr.; *University of Virginia*
16. 3:15 Basal Conglomerate of Mosheim Limestone, Chatham Hill,
Virginia.
F. Webb; *Virginia Polytechnic Institute*
17. 3:30 Faults and Fault Breccias of the Blacksburg-Shawsville Area.
J. B. Deaton; *Virginia Polytechnic Institute*
18. 3:45 Upper Mississippian Sedimentary Structures in the Bluefield
Area.
W. A. Thomas; *Virginia Polytechnic Institute*
19. 4:00 Structure of the Kent Window Area.
F. Marshall; *Virginia Polytechnic Institute*
20. 4:15 Glaciological Measurements on the Ross Ice Shelf.
W. W. Boyd, Jr.; *University of Virginia*
- 4:30 Business Meeting

Section Of Medical Science

Robert H. Brownson, *Chairman*

E. W. Pullen, *Secretary*

W. Parker Anslow, Jr., *Section Editor*

FRIDAY, MAY 8, 1959 — 10:00 A.M. — CONFERENCE ROOM,
NEWCOMB HALL

1. 10:00 Effect of Insulin on Glucose Utilization by Frog Skeletal
Muscle *in vitro*.
D. R. H. Gourley; *University of Virginia School of Medicine*
2. 10:15 The Production of Hemorrhagic Irreversible Shock in the Cat.
Eugene D. Brand; *University of Virginia School of Medicine*
3. 10:30 An Interspecific Study of Per Cent Fatness and of Water
Content of the Fat-Free Body.
Grover C. Pitts; *University of Virginia School of Medicine*
4. 10:45 Metabolic Studies on Frog Skin Epithelium and Epithelium
Homogenate.

Leif Skjelkvale, Kathryn Nieder and Ernst G. Huf; *Medical College of Virginia*

5. 11:00 Urinary Bladder Response in the Cat to Stimulation of the Thalamus, Hypothalamus, Basal Ganglia and Other Forebrain Structures.
Everett H. Ingersoll, Louise L. Jones and Erling S. Hegre; *Medical College of Virginia*
6. 11:15 The Effect of Exposure to Cold on the Response to Alcohol Intoxication of Rats Which are Deficient in Tryptophan and Niacin.
J. C. Forbes and G. M. Duncan; *Medical College of Virginia*
7. 11:30 A Study of the Development of the Sacrococcygeal Region of Human Embryos and Fetuses.
James E. Kindred; *University of Virginia School of Medicine*
8. 11:45 Hypothermia in Thyroidectomized Rats.
Chalmers L. Gemmill; *University of Virginia School of Medicine*
- 12:00 Business Meeting
9. 2:15 Experimentally produced Regeneration of Adult Frog Limbs.
Theodore I. Malinin; *University of Virginia School of Medicine*
10. 2:30 Clinical and Experimental Studies on Nephrosis.
Cornelia Hoch-Ligeti; *University of Virginia School of Medicine*
11. 2:45 X-Irradiation of Rat Central Nervous System.
Robert H. Brownson; *Medical College of Virginia*
12. 3:00 Ovarian Pregnancy.
Bernard A. Heckman and Delilah A. Little (Introduced by James E. Kindred); *University of Virginia School of Medicine*
13. 3:10 Anomalies of the Umbilical Cord in Human Embryos and Fetuses.
Burton D. Goodwin and William M. Runkle (Introduced by James E. Kindred); *University of Virginia School of Medicine*
14. 3:20 Human Monster with Abnormal Development of the Amnion.
David S. O'Brien and Charles L. Gaudry, Jr. (Introduced by James E. Kindred); *University of Virginia School of Medicine*

15. 3:30 Description of Full Term Male "Siamese" Twins of the Thoracopagus Type.
James H. Carraway; Maurice J. O'Connell (Introduced by James E. Kindred); *University of Virginia School of Medicine*
16. 3:40 Dissection of a Human Craniopagus Parietalis.
Robert B. Moore and Arthur H. Wasser (Introduced by James E. Kindred); *University of Virginia School of Medicine*
17. 3:50 Description of a Human Full Term Cyclops.
Louis J. Elsas and John T. Hitchens (Introduced by James E. Kindred); *University of Virginia School of Medicine*
18. 4:00 Anomalies of Kidneys of Human Embryos and Fetuses.
Edwin L. Lyons, Robert K. Maddock, Jr., and Alan D. Rosenthal (Introduced by James E. Kindred); *University of Virginia School of Medicine*
19. 4:10 Absorption, Distribution, and Excretion of Methocarbamol.
Leah L. Eubank, Frances K. Coles, Addison D. Campbell and Ernst G. Huf; *Medical College of Virginia*

Section Of Psychology

Merton E. Carver, *Chairman*

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Penelope Lewis, *Secretary-Treasurer*

Cyril R. Mill, *Section Editor*

FRIDAY MORNING, MAY 8, — 10:00 A.M. — NEWCOMB HALL 4C

Kenneth E. Lloyd, *Session Chairman*

1. 10:00 Painless Electrical Cutaneous Stimulation.
Robert H. Gibson; *University of Virginia*
2. 10:15 An Investigation of Short Term Memory.
John B. Feallock; *University of Virginia*
3. 10:30 The Inter-Trial Interval in Avoidance Training.
Raymond H. Kirby; *College of William and Mary*
4. 10:45 Partial Recognition, Word Frequency, and Responses Bias.
William F. Hawkins; *University of Virginia*

5. 11:00 Attitudes of Parents and Educators toward Sex Instruction in Public Schools.
Cyril R. Mill; *Department of Mental Hygiene and Hospitals*
6. 11:15 Panel Discussion: The Miami Conference on Graduate Education in Psychology.
Moderators Frank W. Finger; *University of Virginia*
7. 12:30 Lunch

John F. Hahn, *Session Chairman*
8. 2:00 Non-sexual Behaviors Induced by an Estrogen.
Robert L. Rhyne; *University of Virginia*
9. 2:15 A Modification of the Iowa Picture Interpretation Test.
David Rice; *College of William and Mary*
10. 2:30 A Second Report on Achievement Imagery and ACE Scores as Predictors of Grades in General Psychology.
John E. Williams; *University of Richmond*
11. 2:45 The Effects of Failure and Achievement Imagery on Arithmetic Performance.
Robert A. Johnson; *University of Richmond*
12. 3:00 Humans in a Puzzle Box.
Peter Guthrie and Henry Schwartz; *College of William and Mary*
13. 3:15 AF: A New approach to the Concept of Achievement.
Robert M. Roth, and Jean Gilbert; *Hampton Institute*
14. 3:30 Discussion: Implications of the National Defense Education Act for Psychologists
15. 4:30 Business Meeting.
16. 5:30 Social Hour and Dinner at The Steak House

SATURDAY, MAY 9 — 9:00 A.M. — NEWCOMB HALL

Robert A. Johnston, *Session Chairman*

17. 9:00 The Reinforcement Variable in Verbal Operant Conditioning.
Richard DeWilde; *College of William and Mary*
18. 9:15 The "Doctor of Psychology" as a Professional Degree.
Dell Lebo and Leland W. Calvin; *Richmond Professional Institute*

19. 9:30 Differential Drug Effects on Schedules of Reinforcement in the Pigeon.
Arthur J. Bachrach and Janice Gibson; *University of Virginia School of Medicine*
20. 9:45 The Perception of Form in the Peripheral Retina.
William B. Camm; *College of William and Mary*
21. 10:00 Drinking Behavior as a Function of Saline Injections and Water Deprivation.
James F. Campbell, Jr.; *University of Virginia*
22. 10:15 The Present Status of Recorded Sound Stimuli Association Tests
Dell Lebo and Roselyn Sherman Bruce; *Richmond Professional Institute*
23. 10:30 A Comparison of Science and Non-Science Students on the Morgan Test of Logical Reasoning.
Fred K. McCoy; *University of Richmond*

CONCURRENT SESSION

SATURDAY, MAY 9 — 9:00 A.M. — NEWCOMB HALL

William F. Battig, *Session Chairman*

24. 9:00 A Discussion of the Concepts of Play.
Jacob Silverberg; *Department of Mental Hygiene and Hospitals*
25. 9:15 Nine Years of Diagnosis and Treatment at the Lynchburg College Reading Center.
William D. Brown and Louann Bolden; *Lynchburg College*
26. 9:30 Detection and Recognition of Non-uniform Visual Targets.
E. Ray Harcum; *College of William and Mary*
27. 9:45 The Lowry Reasoning Test Combination as a Status — Free Device for a Personnel Selection Problem.
R. S. Andrews; *QM Field Evaluation Agency*,
R. O. Lucier; *Courtney and Co.*, and
Dell Lebo; *Richmond Professional Institute*
28. 10:00 Counseling with a Group of Mentally Retarded Children in the Public School Setting.
Cora Lynn C. Goldsborought; *Arlington County Schools*
29. 10:15 The Olfactory Sensitivity of the Rat to Some Homologous Hydrocarbons.

William R. Goff; *University of Virginia*

30. 10:30 Determining Aptitudes by Fiat.
Henry E. Garrett; *University of Virginia*
31. 10:45 Intermission
32. 11:00 Business Meeting: Virginia Psychological Association
Gilbert J. Rich, *President*
Cletus A. Cole, *Vice-President*
Cora Lynn C. Goldsborough, *Secretary*
Jacob Silverberg, *Treasurer*

Section Of Science Teachers

Mae Jennings, *Chairman*

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Virginia C. Ellett, *Secretary*

Caroline Gambrell, *Section Editor*

THURSDAY, MAY 7, 1959 — 1:00 P.M. — PEABODY 104

1:00 Teaching Materials. Booth 7.

Demonstrators A. B. Niemeyer, Jr.

1. 1:00 Setting and Maintaining Standards in Today's Schools.
Franklin D. Kizer; *Assistant Supervisor of Secondary Education*
2. 1:20 What the Virginia Junior Academy of Science has Meant to Me.
Joanna Hackman; *Hollins College*, and Robert Dunning
3. 1:30 Research and Techniques to Raise the Level of Instruction in Physics and General Science.
Edward North; *Washington and Lee High School*
4. 2:10 Recent Advances in Cytology.
Henry G. Kupfer; *Department of Clinical Pathology, Medical College of Virginia*
5. 2:50 The Role of the Virginia Department of Agriculture and Immigration in the Economic Growth and Development of Virginia.

Parke C. Brinkley; *Commissioner, Department of Agriculture and Immigration*

- 3:30 Audio-visual Laboratory, Cabell Hall
Visual Aids and Graphic Arts in Science and Mathematics Teaching.
Sponsored by Participants in the NSF Academic Year Institute.
Presented by Frank Moore and Ertle Thompson; *University of Virginia*.

Section Of Statistics

J. W. Griswold, *Chairman*

Ira A. DeArmon, Jr., *Vice-Chairman*

R. J. Freund, *Secretary*

Clyde Y. Kramer, *Section Editor*

FRIDAY, MAY 8, 1959 — 9:00 A.M. — NEWCOMB HALL 4B

1. 9:00 Introductory Remarks by the Chairman
2. 9:10 Applications of Computers to Medical Research.
Frank W. Banghart; *University of Virginia*
3. 9:30 Linear Programming Applications.
N. L. Enrick and S. C. Lawrence; *Institute of Textile Technology*
4. 9:50 Aspects of Risk Programming.
R. J. Freund and M. E. Rein; *Virginia Polytechnic Institute*
- 10:10 Intermission
5. 10:20 Traffic Volume Estimates; Probability Applications.
Marvin Tummins; *Virginia Council of Highway Investigation and Research*
6. 10:40 A Method of Scheduling.
M. F. Peck; *Virginia Polytechnic Institute*
7. 11:00 Notes of the Detection of Wearout.
C. W. Clunies-Ross; *Virginia Polytechnic Institute*
8. 11:20 Some Problems of Inventory Control.
R. L. Chaddha; *Virginia Polytechnic Institute*

9. 11:35 Statistical Theory and Economic Theory, a Comparison of Concepts of Decision Making.
D. Rutledge Vining; *University of Virginia*
10. 2:00 Path Analysis, Linear and Non-linear.
M. Turner; *Medical College of Virginia*
11. 2:45 Business Meeting
12. 3:15 A Comparison of Internal and External Assay Variation in Virulence Testing of Bacillus Anthracis Spores.
I. A. DeArmon, Jr.; *Fort Dietrick, Maryland*
13. 3:40 Graded vs. All-or-None Response in Bioassay.
F. M. Bradley; *Fort Dietrick, Maryland*
14. 4:00 Some Uses of Statistics in Plant Maintenance.
J. Armstrong; *DuPont, Richmond*

SATURDAY, MAY 9, 1959 — 9:00 A.M. — NEWCOMB HALL 4B

15. 9:00 Multivariate Sequential Procedures for Testing Means (Preliminary Report).
J. E. Jackson; *Virginia Polytechnic Institute*
16. 9:20 On Comparing Different Tests of the Same Hypothesis.
H. A. David; *Virginia Polytechnic Institute*
17. 9:40 A Study of Multivariate Confidence Bonds.
R. E. Bargmann; *Virginia Polytechnic Institute*
18. 10:00 Extremal Methods in Estimating Procedures.
D. C. Hurst; *Virginia Polytechnic Institute*
19. 10:20 Intermission
20. 10:30 Two-way Rank Sum Tests for Variances.
A. R. Ansari and R. A. Bradley; *Virginia Polytechnic Institute*
21. 11:10 A Comparison of the Effectiveness of Tournaments.
W. A. Glenn; *Virginia Polytechnic Institute*
22. 11:30 Factorials in Associated Incomplete Block Designs.
L. S. Brenna and C. Y. Kramer; *Virginia Polytechnic Institute*

THE ANNUAL SUBSCRIPTION RATE is \$3.00, and the cost of a single number, \$1.00. Reprints are available only if ordered when galley proof is returned. All orders except those involving exchanges should be addressed to Charles F. Lane, Stevens Hall, Longwood College, Farmville, Virginia. The University of Virginia Library has exclusive exchange arrangements, and communications relative to exchange should be addressed to The Librarian, Alderman Library, University of Virginia, Charlottesville, Virginia.

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Contributions to the Journal should be addressed to Robert T. Brumfield, Stevens Hall, Longwood College, Farmville, Virginia. If any preliminary notes have been published on the subject which is submitted to the editors, a statement to that effect must accompany the manuscript.

Manuscripts must be submitted in triplicate, typewritten in double spacing on standard 8½" x 11" paper, with at least a one inch margin on all sides. Manuscripts are limited to seven pages, with the proviso that if additional pages are desired, the author may obtain them at cost. The author may estimate the length of his paper by counting the total number of characters, including blank spaces, and dividing this by 3300. The result is the approximate number of printed pages in the Journal.

Division of the manuscripts into subheadings must follow a consistent plan, and be held to a minimum. It is desirable that a brief summary be included in all manuscripts.

Footnotes should be included in the body of the manuscript immediately following the reference, and set off by a dashed-line above and below the footnote content. Footnotes should be numbered consecutively from the beginning to the end of the manuscript.

Bibliographies (Literature Cited, References, etc.) should be arranged alphabetically according to author. Each reference should include the date, full title of the article, the name of the Journal, the volume, number (optional), pages, tables and figures (if any). For example: "Sniffen, Ernest W. 1940. Cobbles from the Pleistocene Terraces of the Lower York-James Peninsula Va. *Journ. Sci.*, 1 (8): 235-238, 1 fig., 1 tab. Reference to the bibliographic citations should not be made by numbers. Instead, using the above citations, where a reference is desired: either "Sniffen (1940)", (Sniffen, 1940: 186)", or "Sniffen (1940) states that . . ."

Explanation of figures, graphs, etc., should be typed on separate pages. All figures should be numbered consecutively beginning with the first text figure and continuing through the plates. If figures are to be inserted in the text this should be clearly indicated by writing "Figure —" at the appropriate place in the margin.

Illustrations including lettering, should be arranged so that on reduction they will not exceed the dimensions of the maximum size of a printed page. 4-1/2" x 6-1/2", and so that they are well balanced on the page. Large plates must be accompanied by 8-1/2" x 11" photographic copies which can be sent to the reviewers. The Journal will furnish the author with one plate (halftone or line reproduction) or its equivalent; additional figures, colored illustrations or lithographs may be used only if the author makes a grant covering the cost of production. Original drawings (which must be done in black drawing ink) not photographs of drawings, should accompany the manuscript. Photographs should not be used if a line and dot (stippled) drawing will suffice. If photographic prints are to be used they should be glossy, sharp and show good contrast. Drawings not neatly executed and labeled (do not use a typewriter), or which are submitted on yellow or yellowish-white paper will not be accepted.

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C O N T E N T S

	<i>Pages</i>
<i>Ginkgo Biloba</i> L: Historical Summary and Bibliography— ALICELIA HOSKINS FRANKLIN	131
A Preliminary Report On An Occurrence Of <i>Campostoma Anomalum</i> (Rafinesque) In The Yadkin River Drainage System— B. J. ABBOTT	177
The Tube Precipitation Technique As Applied To The Study Of Serological Relationships Among Crayfishes— ROSE MARY JOHNSON	181
The <i>In Vitro</i> Effects of X-Radiation On Human White Blood Cells— SAMUEL P. MARONEY, JR.	186
News and Notes	193

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GINKGO BILOBA L: HISTORICAL SUMMARY AND BIBLIOGRAPHY

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HISTORICAL SUMMARY

GEOLOGICAL HISTORY.—*Ginkgo biloba*, the sole survivor of the family Ginkgoaceae, which in turn comprises the entire group or order Ginkgoales, represents a distinct plant form whose ancestry can be traced 200 million years or more into the past. Ginkgos evolved from the ancient seed-bearing ferns and first existed as small trees along the borders of the shallow seas. When the great Mesozoic Reptiles, among them *Brontosaurus* and *Diplodocus* lived in the shallow waters and fed upon the cycads, ferns and club mosses, the *Ginkgo* migrated to the tops of the gently rising hills, and grew to a height of 100 feet or more—too great for even an eighty foot dinosaur to reach. In this war between the destructive herbivorous reptiles and the plant life of their time, (a war which meant extinction for many other species) the *Ginkgo* survived. Through millions of years the ginkgos grew in the steamy forest atmosphere, living on somewhat higher ground than many of the early tree-like forms. The uplands of the Triassic and Jurassic ages became covered with ginkgo leaves bedded through endless generations and the trees still arched their enormous branches. In the Tertiary forests, the mammoth came and sharpened his tusks upon the trunk of the ginkgo tree, the sabertoothed tiger lurked in its shade and mice made their homes in its roots. Of early trees which survived the glacial period, F. H. Lamb (1938) states that the following are still in existence: two taxad cypresses (one living along the Gulf and South Atlantic coasts of the United States, the other the Montezuma Cypress of Mexico), the Giant Sequoias of California, and the Cryptomerias of East Asia and Japan; south of the equator other survivors include the podocarps, and the Kanri and Norfolk Pines of New Zealand, South Africa and the Pacific Islands.

From the Triassic to the Tertiary Period the ginkgos spread over most of the Northern Hemisphere and parts of the Southern. Warm

valleys in Greenland and Alaska became filled with enormous ginkgo trees. Ginkgo colonies were liberally distributed in Europe. Ginkgos were present in South America, South Africa, Australia, Asia and even Siberia. In America a few members of the ginkgo family thrived in what is now North Carolina, and they are widely distributed over what is now the Dakotas, Wyoming, Montana, Washington, and Oregon.

As the Triassic age came to a close more than 150 million years ago, the Ginkgoales boasted two large groups of the family, notably *Ginkgo* and *Baiera*. With the advent of the Jurassic we find other genera added to the growing family, increasing in volume through the Early Cretaceous age—genera which established themselves over a vast extent of territory both north and south of the equator. Only in Antarctica were there no Ginkgoales. At this time the ginkgo family was more widely spread than at any other era of its development, but during the Late Cretaceous its world wide distribution began to dwindle. The Cretaceous sea with its heavy concentrations of marine life flooded vast continents, and as a result the flora of the earth changed to a more modern aspect. A world-wide burst of evolution brought the angiosperms to prominence. *Ginkgo biloba* and only a few of its close relatives adapted to the chalky hills left by the calcareous oceans and survived the competition enforced by the new plant life. However, American, Arctic, European, and Asiatic forests could boast of widely dispersed Ginkgo trees. During this time the Ginkgo gradually became restricted to the North Temperate Zone as a result of competition from neotropical forests encroaching from the south.

During the Tertiary Period came a new threat. Great land upheavals accompanying the evolution of the Pyrenees, the Alps, and later the Andes mountains caused the great forests of *Ginkgo* to fall. New generations of *Ginkgo* took their places, but they were in isolated groups, separated by mountain chains, deserts and dry plains. In Oregon and Washington the rise of the Cascade Mountains cut off the summer moisture from the Pacific. This, combined with winter cold, hastened their end in this area.

At the end of the Tertiary Period a tremendous change took place in the northern continents. Cold gripped the world. Ice covered the northern latitudes extending into the temperate zones. In the face of these arctic conditions the ginkgos dwindled in number. Probably the Pleistocene was their last appearance in Europe. As the ice sheet moved southward with successive advances, the ginkgos gave ground, though they recovered lost valleys sporadically whenever the ice receded. Finally the ice completely overwhelmed these northern forests and swept all life before it far into the south temperate regions. The *Ginkgo* was unable to cross the Alps. In America the great cold preceding the ice sheets moved as far south as Philadelphia and California. If any stands of *Ginkgo* remained in the northwest they were unable to cross the Sierras

into California as *Sequoia* did. Thus they met extinction on this continent.

Only in East Asia, where the destructive ice halted in its southward progression, was the *Ginkgo* able to survive. Nestling in some warm secluded valley where it could migrate southward in those mountain chains where the ridges run in a northerly-southerly direction, *Ginkgo biloba* was spared complete extinction during the Ice Age. This sole survivor of a once numerous family retained its basic heritage through millions of years to appeal to the imagination of man, who with his cultivating hand would preserve this relic of an ancient past.

GENERAL DESCRIPTION.—Let us take a look at this deciduous, naked-seeded gymnosperm which so populated the earth at one time. *Ginkgo* in winter dress resembled the larch in general shape when young, with its slender pyramidal branching. When old its shape somewhat resembled that of the Douglas fir, especially in fastigate varieties, but in some cases it became spreading with a dense head. Individual trees could reach the age of 1,000 years, being surpassed in longevity only by the California Sequoia (3,500 years) and the Bristlecone Pine (4,600 years) *Ginkgo* stretched its branches higher than 100 feet and its girth exceeded 20 feet. Its bark was greyish, deeply furrowed on old trees. Branches whorled from the trunk at irregular intervals—some were erect and formed duplicate leaders. Branchlets drooped or were horizontal, continuing to produce short spur-like shoots for many years (as in larch or in cedar), and then suddenly lengthening out into long shoots. Sharp-pointed conical buds with bright brown scales terminated the short shoots which were crowded with leaf scars of past years. The branches in winter were a light golden brown.

In spring, leaves appeared in whorled clusters of six or less at the short shoots, and scattered along the length of the long shoots. The ends of the short shoots, and scattered along the length of the long shoots. The leaves varied from one to two or three inches in depth, and from one to three inches in breadth, with occasional exceptions up to six inches. In general aspect the leaf and stalk resembled a fan (the upper edge rounded, entire, irregular undulate, or bilobed). On vigorous young shoots the blade became dissected by V-shaped depressions into four or more wedge-shaped sections, and occasionally there were deeply cuneate leaves found in the seedlings or in new growth reviving from old roots, recapitulating the leaves of its ancestors. In spring these leaves were a light green, in summer a deeper glabrous leathery green, and in fall they turned a rich golden yellow before dropping in a clean and sudden fall.

In venation and shape these leaves appeared much like the leaves of the maidenhair fern or *Adiantum*. The two strands of connective

tissue from the forked veins in the stem radiated into the leaves, ending in numerous parallel veins which were interspersed with stomata and secretory cells exuding a sticky fluid.

On trees of twenty years or more, flowers appeared in May. The male blossoms were small, pendulous catkins on the short stalks, three to six upon a shoot, bearing loosely arranged stamens. The female flowers (mere naked ovules) emerged from the short shoots in pairs of two or three, growing to stand erect upon their long stiff stalks rimmed at the juncture by a collar. The pollen blew across the forests thick and yellow, depositing itself upon the sticky ovule for the propagation of a new generation. In time a small plum-like fruit, containing a hard-shelled nut with a kernel, developed upon the stalk. The fruits in turn fell to the ground in early September giving off a most offensive odor. In the fall two spermatozoids developed from the pollen within the ovule, swimming in a sac of simulated sea water, to fertilize the egg cell. The developing embryo within the seed lay where it fell in the woodland duff, or was planted by small animals in the woodland loam. In spring two cotyledons followed by five cuneate leaves appeared on the ground underneath the big old tree's shade. Sometimes the ancient trees would produce peg-like structures (air roots) from the trunk or lower branches, which would produce true roots upon touching the ground, and then produce branches above it. Sometimes the old tree died and the new sprouts took its place. Generation followed upon generation for millions of years with virtually no change in the *Ginkgo biloba*.

GINKGO IN THE ORIENT.—In some remote valley of the forests of China, the *Ginkgo biloba* overstayed its time. Although its ancestors had covered the entire world, this remnant of one of the "first families" of trees now remained hidden from those who sought its native habitat. Some reported seeing it in the wild state. Mrs. Bishop (Bird, 1880) traveled widely in the Orient at the end of the last century and reported that she had seen it growing natively in Japan in the great forests of the northern island Yezo, and also in the country at the sources of the Great Gold and Min Rivers in Western China. The foresters of Japan denied however that the *Ginkgo* was indigenous to that country in historic times, maintaining that it was introduced from China, perhaps by the Buddhist monks, about a thousand years ago.

E. H. Wilson (1913), travelling for the Arnold Arboretum fifty years ago believed that the *Ginkgo* no longer existed in the wild state. His travels, though extensive in range, followed the main river valleys, and were intensive in the area of Lushan in Northern Kiangsi in eastern China, and in western China in western Hupeh and Szechuan. His itinerary barely missed the stand of truly wild *Metasequoia*, another rare remnant from before the Ice Age. Perhaps he missed the *Ginkgo* also.

Yet another botanical explorer for the Department of Agriculture, Frank Meyer, travelling for the discovery of useful native plants of China, searched the southerly approaches to the Chinese mountains while Wilson was exploring the more northerly sector. He maintained that the *Ginkgo* grew spontaneously (according to Wilson, 1913) near Hsien, about 70 miles west of Hanchow, in the Chekiang Province of China, where he reported the *Ginkgo* was so common that it was cut for fire wood. Whether this stand of *Ginkgo*, lying in the Tien Mu Shan Range, along the northwestern border of Chekiang and Southeastern Anhwei and attaining a topmost altitude of 5,000 feet, represented the last wild *Ginkgo* cannot now be verified, since the prodigious accumulation of population and resulting cultivation in China has meant depredation of the wild forests.

However, there were Chinese who collected *Ginkgo* in this area, also in the mountains of southwest Kweichow and Szechuan, and believed that it grew spontaneously, in association with conifers and broad-leaved trees. This area of Chekiang, according to Hui Lin Li (1956) is the habitat of some other relic plants, among them *Pseudolarix* and *Nothotaxus*. *Torreya grandis* and *Carya cathayensis* also occur in this region, as do the semi-wild and cultivated *Ginkgo*. So possibly it was in this region that *Ginkgo* was finally preserved from extinction and later cultivated by the ancient Chinese who used the nuts for food. Certainly this is the region from which all our cultivated trees of today have been derived.

In these mountain fastnesses far from habitation it attains a height of over a hundred feet. It is also found in the vicinity of temples and private gardens where the native plants have been preserved, and is a very common tree in an area where primeval forests no longer exist.

Ginkgo may have been known to the populace of Kiangsu and Anhwei during the Tsin Dynasty (240-420 A.D.) and has been attributed the name of P'ing Chung Kuo in poetical essay by Wu Tu Fu.¹

According to Bretschneider, all plants mentioned in the literature before the first century, B. C., can be presumed to have originated in China, as there was no possibility of communication with the outside world at that time. It was still some centuries before the Chinese traded as far south as India.

Bretschneider also states that a single character in Chinese indicates antiquity, thus of the name Yin Sing (Silver Apricot) for the *Ginkgo*, the single character for Apricot is of ancient origin. The name Ya Chio (leaf

¹According to botanists Li Shih-chen in 1956, and Wu Chi-chum in 1948 who studied this literary work.

of a Duck's Foot), is perhaps older, since it appears to have originated the southern provinces, the native haunt of *Ginko*. The earliest civilization of the Chinese flourished in the north of China along the Yellow River and although many indigenous plants are mentioned in the early literature of this period in North China apparently *Ginkgo* is lacking. Since Ya Chio is written in two or sometimes three idiographs, it indicates a later introduction from the South.

During the Sung Dynasty of the eleventh century there are many records of this tree in cultivation along the Yangtze River. It has been reported by Hui Lin Li (1956) that a Sung notebook entitled "Shi Hua Ching Duei" proclaimed: "In the Capitol (Kaifeng) there was originally no Ya Chio (Duck's Foot). Since Prince Li Wen-ho came from the south and transplanted it to his residence, it becomes famous. From then it gradually propagates and multiplies, and fruits from the south are no longer considered precious."

As a result of early Chinese agriculture, many botanical works were published in medieval times. A medicinal use for early plants was subscribed to in many instances. *Ginkgo* seed eaten raw has been touted as an expectorant and as a cure for cancer. However, the toxic effects of the raw seed sometimes prove to be fatal. One herbal by Wu Jui called "Jih Jung Pen Ts'ao" recounts that even the cooked nuts if eaten in excess, especially by children may prove to be slightly toxic. In spite of this warning note, the *Ginkgo* was extensively cultivated as a source of food, and was considered a delicacy when roasted for festive occasions.

The peoples of the orient have used the *Ginkgo* in the preparation of a kind of cosmetic when the seeds are soaked in wine. The Chinese even use the seed pulp combined with lye as a soap to wash clothes. It has wood uses of a very limited sort as the grain is much like white pine. Abacus beads have been made from it; chessmen also. It is widely used as the base for fine oriental lacquerware.

According to some early botanical records the Chinese were aware that *Ginkgo*, which is dioecious with pistillate and staminate reproductive organs on separate plants, should be planted with the two kinds together to insure fruiting. But other early records stated that the female tree when planted alone beside water would produce seed. This may be ascribed to the fact that the ovule develops much starch even without fertilization. Grafting of a male branch upon a female tree was also practiced as a method of insuring the crop. Seed shape was considered to be a sex determinant. Those seeds with three ridges on the two-pointed nut were supposed to yield male trees, while those with two were supposed to yield females. The accuracy of this belief does not appear to have been demonstrated, as three-sided *Ginkgo* nuts are rare.

The *Ginkgo* was also planted for its aesthetic value, being trans-

planted and cared for in private gardens and temple grounds, often perched on some mountain crag, adding an aura of charm to the temples. In time it became known as the sacred *Ginkgo*. Lengthy legends grew up around the old tree, for the people of the orient have revered and preserved these *Ginkgo*, decorating them as shrines with incense stands. The temple grounds provided a sanctuary for the *Ginkgo* along with much of the indigenous flora of the orient, since the Buddhist and Taoist priests preserved the forests surrounding their temples. Consequently there are *Ginkgo* trees of enormous size in many venerable temple enclosures.

The temple tree, *Ginkgo*, is next found to be introduced into Japan. Although the exact date is unknown, some have supposed it was imported with Buddhism, or at least to have come to Japan by the end of the Sung Dynasty of the eleventh century. Japanese botanists assume a minimal date of 1,000 years residence for *Ginkgo* in Japan, since there are living specimens of approximately that age at the present time.

In Japan, the *Ginkgo* leaves are ground for fertilizer, and are used as an insecticide when spread around the base of plants. School children place *Ginkgo* leaves in their books "to scare the worms away." Young girls' hair styles and artists' designs derive inspiration from the shape of the leaf. *Ginkgo* is woven in many ways into the pattern of oriental life.

GINKGO IN THE WESTERN WORLD.—*Ginkgo* first became known to the western world when Dr. Englebert Kaempfer, a ship's doctor in the employ of the Dutch East India Company, searched the Far East during his extensive travels for a tree which he had previously seen in Japan in 1690. It is believed that he obtained the tree in south China, and brought it back to Holland. Perhaps it became the famous old *ginkgo* in the Botanical Garden at Utrecht.

He published a description of it in his *Amoenitatum exoticarum* (1712), containing a drawing of a leafed branch with ovule. He called it "*Ginkgo* vel Ginan, vulgo Itsojo, arbor nucifera folio adianto."

There has been much speculation as to the origin of the name *Ginkgo*, since there is no word corresponding exactly to this spelling in either Chinese or Japanese literature. Kaempfer's fifth and last fascicle of his work *Amoenitatum exoticarum* introduced the name as indicative of the Chinese literary idograph for Yin Sing (Silver Apricot) as pronounced in Japan. The Rev. Dr. A. C. Moule, a Professor of Chinese at Cambridge University has pointed out that there are no grounds for the termination -kgo, which is "unpronounceable and probably ought never to have existed." In all probability it is a misspelling of the word Gin-yo or or Gin-go of South Chinese origin meaning Silver Apricot, the -kg of the

word ginkgo becoming attached in the process of transliterating the word into Dutch, perhaps the work of Kempfer or one of Kaempfer's assistants.

In 1771 Gorden sent a sample of the leaves to Linnaeus, who included it in his publication *Mantissa plantarum*. To Kaempfer's "*Ginkgo*", which he adopted as the generic name, he added the specific name of "*biloba*" as descriptive of the leaf form which he obtained.

Twenty-six years later, J. E. Smith (1797) in a paper before the Linnaean Society, renamed the tree *Salisburia adiantifolia*. A few authors subsequently wrote papers under this title, but the accepted nomenclature of Linnacus prevailed in spite of Smith's contention that the word ginkgo was "Equally uncouth and barbarous." To this day the *Ginkgo* is known as the Maidenhair Tree in England—a name derived from the form of its leaves which resemble the Maidenhair Fern—the *adiantifolia* of Smith

The tree has been called *Ginkgo*, as a preferred spelling, by the London *Times* in a series of articles and correspondence in February and March in 1946. The *New York Times* and *The New Yorker* have used the plural "*Ginkgoes*"—in a facetious manner (because of the periodic rash of ill-smelling fruits upon the sidewalks during fruiting season). *Ginkgo* is also the spelling found in official usage by the United States Department of Agriculture.

In French literature, reference is often found among the older publications to the "arbre au quarante ecus," referring to the price a M. Petigny paid a nurseryman in England in 1780 for five *Ginkgo* seedlings which he took to France.

Most of the early trees in Europe proved to be staminate trees. De Candolle recorded the first fruiting tree in Geneva in 1814, and was instrumental in having scions grafted on the trees in the Botanic Garden in Montpellier, France, where first permanent seed was produced.

As far as the records show, the *Ginkgo* was first introduced to the United States by William Hamilton, who planted a tree in 1784 in what is now Woodlands Cemetery, West Philadelphia. Although this tree died a few years ago, one of comparable age in John Bartram's Garden in Philadelphia is still thriving.

Since the *Ginkgo* is free from serious pests and diseases, is not particular as to soil, and shows a marked tolerance to city smoke and industrial fumes, it is becoming known as a fine street tree, reaching a height of 40-80 feet. It flourishes particularly in Washington, D. C., and other locations where the climate fulfills the *Ginkgo* requirement for moisture (35 inches of rainfall) and warm nights during the growing season. With sufficient watering, however it grows well in most of the country.

Ginkgo is distributed over all but the coldest states of the north central

United States, where winter cold and limited rainfall fail to provide even minimal conditions. It grows only slowly in the northwest states, which may account for the discrepancy in the literature as to its rate of growth. In the latitude of Chicago or even New York, seedlings will not withstand the winter temperature, but must be protected in a greenhouse. Cuttings will survive in an exposed situation more readily, as will grafted stock. Both of the latter methods of propagation are required when staminate trees or specific varieties are demanded for street planting. Under cultivation, this tree now grows in many countries in the temperate latitudes where it once grew natively before the Ice Age.

HISTORY OF CLASSIFICATION.—The genus *Ginkgo* was included, under Coniferae in *Die Natürlichen Pflanzenfamilien*, in the Taxae with *Taxus*, *Cephalotaxus* and *Torreya*. Eichler had previously referred *Ginkgo*, or *Salisburia* to a separate family—the Salisbureae. The most remarkable botanical event in the late 19th century then occurred. Hirase, a servant in the laboratory of Matsumura in Tokyo, asked his master for a problem in botany, since he had learned the use of a microscope. Recalling that the reproductive mechanism of *Ginkgo* had yet to be determined, his master referred Hirase to the *Ginkgo* tree outside the door. Hirase's discovery in 1896 of the motile antherozoid in the pollen tube of *Ginkgo* confirmed a growing suspicion among taxonomists that the classification of *Ginkgo* with *Taxus* and other Coniferae was no longer consistent. Following this discovery Engler adopted the family name *Ginkgoaceae*, and further isolated its position by placing it in the special class of Ginkgoales.

Dallimore and Jackson list the varieties of *fastigata* (columnar in form with branches erect), *macrophylla laciniata* (with leaves larger and more deeply cut), and *variegata* (whose leaves are variegated with yellow). Other varieties have sometimes been named, or differentiated and again disputed.

EPILOGUE

Ages before a unique creature called man discovered its usefulness, and made it his original nut tree, the *Ginkgo* inherited the earth. In a world comprised of mountains where there are now valleys, and water where there are now hills, prior to the formation of the Rockies and the Urals, it demonstrated everywhere its extraordinary vitality, adaptability, and resiliency to the changing environment. In times of temporary drought it preserved its cellular structure enough to revive—coming up from the roots when otherwise appearing dead. It receded here to revive again elsewhere. It crossed the temporary land bridge between Asia and America by way of Alaska and Siberia, and possibly another land bridge between Asia and America by way of Greenland and Franz Joseph Land. In general it liked a moist humid climate but could withstand temporary searing by fire. Its trunk with bark which has been compared to an elephant's skin, was pro-

tection against marauders both animal and insect. The leaves were not bothered by insect pests, and the wind carried the pollen from male to female tree for thousands of generations.

The great enigma in the investigation of *Ginkgo* still hinges around the problem—the innate question—of how the *Ginkgo* survived the vicissitudes of the passage of time for millions of years during the rise and fall of countless genera upon the face of the earth. Time and its relationships lose meaning for the human mind in the face of such a survival, and some fundamental facts of paleontology find an exception in the reading of the record of *Ginkgo*. *Ginkgo biloba* L. indeed has a preeminent claim to be designated in Darwin's words "a living fossil."

BIBLIOGRAPHY

This bibliography was compiled for the University of Virginia with funds provided by Mr. John Lee Pratt under the supervision of Dr. Randolph T. Major of the Cobb Chemical Laboratory of the University, and with the encouragement of Dr. Ladley Husted of the Biology department of that University.

The bibliography encompasses all aspects of the literature of the living *Ginkgo* from the more general paleobotanical and historical works to the research investigations on taxonomy, morphology, reproductive system, cytology, chemistry, pharmacology, and horticulture, which are obtainable in Washington, D. C.. It includes the research published during the years of 1880 to the summer of 1958, and lists only those earlier works of particular historical interest. For extensive bibliographies of the 19th century investigators, consult A. Seward and J. Gowan, *The Maiden-hair Tree*, Annals of Botany, London 1900; and A. Specher, *Ginkgo biloba* L., Geneva, 1907. Unpublished material may be found in the Hill Culture Section Reports of the Pre-World War II Soil Conservation Service of the U. S. National Archives. The Plant Science Catalogue of the Department of Agriculture lists 141 publications on the *Ginkgo biloba* which are included in this bibliography.

Dr. Samuel Detwiler, retired, and Miss Doris Hayes of the Department of Agriculture; Mr. Oliver Shipley and others of the Staff of the Department of Agriculture Library; Dr. Roland Brown of the Geological Survey were of great help, as were Mr. Wm. V. Heers and Miss Guerry Newton of the Geological and Paleobotanical Libraries. The Orientalia and Science Sections of the Library of Congress were also of assistance. Miss Marie Siegrist of the Geological Society of America Bibliographic Staff gave encouragement.

A number of papers written in Japanese have been translated by Dr. Joseph Yoshioka of Bethesda, Maryland, and a number of those in

French and German by the author. These translations, together with a set of notes and abstracts, may be obtained from the author by those wishing to pursue research on the *Ginkgo*.

It is hoped that this historical background and the following bibliography will aid investigators studying the *Ginkgo*, and that further research will provide new information on the reasons for its survival.

Aberconway, L. 1947. *Ginkgo biloba* (Notes from fellows). *Roy Hort. Soc. Jour.*, 72(1):32.

Achille, R. 1955. Il portere germinale nella cellula del soma confermato da *Ginkgo biloba* L. conifera superstite frale specie del periodo carbonifero Orientamenti. La nuovo via. *Boll. Acad. Gioenia* (3(1):37-42.

Affourtit, M. F. A. and La Riviere, H. C. 1915. On the ribbing of the seeds of *Ginkgo*. *Ann. Bot.*, 29:591-595.

Ahlburg, H. 1878. Uber das Vorkommen der *Ginkgo biloba*. *Flora*, 61:382-383.

American Forestry Association. 1936 and 1957. Open letter on the *Ginkgo*.

Anderson, D. 1954. The structure of the walls of higher plants. *Bot. Rev.*, 1:52.

Andrews, H. N. 1947. Ancient Plants and the World They Lived In. Ithaca, N. Y. *Comstock*, 279p. *Ginkgo*: 159-165.

Anhaeusser, H. 1953. Germination and tube formation by gymnospermous pollen with particular regard to the problem of growth substance. *Beitr. Biol. Pflans.*, 29:297-338.
Chem. Abst., 5590d. 1955.

Anonymous. 1924. The maidenhair tree. *Mo. Bot. Gard. Bull.*, 12 (5): 64, 65.

Anonymous. 1935. Sidelights of the conference. *Nursery Notes*, 4 (11):5.

Anonymous. 1937. The Maidenhair Tree and Its Allies. *Gard. Chron.*, 101 (2628):303.

Anonymous. May 16, 1938. *Ginkgo*. *Washington Times*.

Arnaud, M. (presentee par M. Pasteur). 1889. Recherches sur la carotene; son role physiologique probable dans la feuille. *Acad. des Sci. Compt. Rend.*, 109:911-914.

Arnold, C. A. 1947. An Introduction to Paleobotany. 433p. *Ginkgo*: 273-278.

- Arnold, C. A. 1948. Classification of the Gymnosperms from the viewpoint of paleobotany. *Bot. Gaz.*, 110:2-12.
- Arnold, F. 1944. Plant your ginkgo seeds before snow comes. *Gard. Chron. Amer.*, 48:284-285.
- Arnoldi W. 1903. Beitrage Zur Morphologie der Gymnospermen VI. Über den Bau der Zellkerne im Embryo von *Ginkgo biloba* VII. Die Embryobildung bei *Ginkgo biloba*. *Inst. Agron. et Forest. a Nowo-Alexandria*, 16:1-22.
- Ascherson, P. and Grebner, P. 1912. *Syn. Mitteleur*, Fl. 2, Aufl., 1:260-261
- Augier, J. 1944. Le Raffinose dans le *Ginkgo biloba*. *Soc. Bot. de France Bull.*, 89:113-115.
- Baker, W. and Simmonds, W. H. C. 1940. Derivatives of 5, 6, 4- and 5, 8, 4- trihydroflavones and a note on the structure of ginkgetin. *Jour. Chem. Soc.*, p. 1370-1374.
- Bailey, L. H. 1923. *Ginkgo*. Cultivated Evergreens. London, *Macmillan*, 434p. *Ginkgo*: 77, 177, 178.
- Bailey, L. H. 1941. *The Standard Cyclopedia of Horticulture II*. New York, *Macmillan*, 2421p. *Ginkgo*: 1338.
- Baillon, H. 1860: *Adasonia*, 1:11.
- Ball, E. 1954. Experiments on the embryo of *Ginkgo biloba*. VIII. *Congr. Internatl. Bot. Paris. Rapports in Commun. Sec.*, 8:265-267. *Biol. Abst.*, 26860. 1955
- Ball, E. 1956a. Growth of the embryo of *Ginkgo biloba* under experimental conditions. I: Origin of the first root of the seedling *in vitro*. *Amer. Jour. Bot.*, 43 (7):488-495.
- Ball, E. 1956b. Growth of the embryo of *Ginkgo biloba* under experimental conditions, II Effects of a longitudinal split in the tip of the hypocotyl. *Amer. Jour. Bot.*, 43(12):802-810.
- Bannen, M. V. 1936. A comparison of the distribution of albuminous and tracheary ray cells in gymnosperms. *Amer. Jour. Bot.*, 23 (1): 36-40. *Biol. Abst.*, 9298. 1936.
- Barclay, J. G. 1944. The name *Ginkgo*. *Roy. Hort. Soc. Jour.*, 69:68-69.
- Bastin, E. 1950. Strange survivor. *Nature Mag.*, 43 (8):410.
- Baxter, D. 1952. *Pathology in Forest Practice*. Ed. 2, New York and London, *Wiley*, 618p. *Ginkgo*: p. 5, 394.

- Baxter, S. N. 1938. The Ginkgo—Earth's Oldest Tree. *Parks and Recreation*. 22(10):57.
- Beauverie, J. 1933. Les Gymnospermes vivantes et fossiles, Cours de Botanique, professe a la Faculte des Sciences de Lyon, Lyon, *Bosc. Freres, M. et L. Riow*, 160p. Ginkgo: p. 3, 22-23, 34, 52, 92, 102, 133-134.
- Bechamp, M. A. 1846. Sur l'existence de plusieurs acides gras odorants et homologues dans le fruit du *Ginkgo biloba*. *Acad. des Sci. Compt. Rend.*, 58:135.
Ann. Chem., 130:314. 1864.
- Beck, G. F. 1935. The quest of the sacred *Ginkgo*. *Wash. Hist. Quart.*, 26(1):3-9.
- Beilmann, A. 1932. Adventitious roots from ginkgo leaves. *Mo. Bot. Gard. Bull.*, 20(3):53-54.
- Beisner, L. 1930. Handbuch der nadelholzkunde Systematik, beschreibung, und kultur der ginkgoaceen, frieland-conciferen und gnetaceen. *Fur gartner forstleute und botaniker, bearb.*, von L. Beissner—2; *vollig umgearb, verm, und verb. ufl.*, Berlin, *Parey*, 765p. Ginkgo: p. 4, 31, 33.
- Belajeff, W. 1897. Uber den nebenkern in Spermatogenen Zellen und die Spermatogenese bei den farnkrauten. *Deut. Bot. Gesell. Ber.*, 15:337.
- Benson, L. 1957. Plant Classification. Boston, *Heath* 688p.
- Berry, E. W. 1920. Paleobotany: A sketch of the Origin and Evolution of Floras. *Smithsonian Inst. Ann. Report for 1918* p. 355-359. *Washington Govt. Printing Office*, p. 289-407.
- Berry, E. W. 1933, pub. 1934. Former Land Connection between Asia and N. America as indicated by the Distribution of fossil trees. *5th Pacific Sci. Cong. Proc.*, 4:3093-3100.
- Berry, E. W. 1938. Additional Miocene plants from Grand Coulee, Wash. *Bull. Torrey Bot. Club*, 65:89-98.
- Bessey, E. A. 1901. Notes on the spermatozoids of *Ginkgo*. *Science*, 13:255.
- Bird, I. 1880. (Mrs. Bishop). Unbeaten Tracks in Japan. London.
- Blakeslee, A. F. and Jarvis, C. D. 1931. Trees in Winter. New York, *Macmillan*, 292p. Ginkgo: p. 96.
- Blasdale, W. C. 1899. A Description of Some Chinese Vegetable Food Materials. U. S. D. A. *Off. Expt. Sta. Bull.*, 86:44, 45.

- Bliss, M. C. 1918 Interrelationships of the Taxaceae *Bot. Gaz.*, 42:54-59.
- Bold, H. C. 1957. Morphology of Plants. New York, *Harper Bros.*, 669p.
- Bouffieux, M. R. 1929. The Ginkgo tree—ancient and modern. *Flow. Grow.*, 16(2):45-48.
- Boureau, E., Furon, R., and Rosset, L. F. 1950. Contribution a l'étude flores jurassiques d'Asie II Le plateau iranien. Paris, *Mus. d'Hist. Nat. Mem.*, 30 (2): 207-242.
- Bowen, G. R. 1939. Selection, Care and Culture of Shade and Ornamental Trees. Syracuse, N. Y., thesis (PhD), N. Y. State College of Forestry.
- Bretschneider, E. 1876. Notes of the medieval geography and history of central and western Asia. *Roy. Asiatic Soc. of Great Britain and Ireland, N. China Branch, Shanghai Jour.*, (n. s.) 10:75-307.
- Bretschneider, E. 1882-95. Botanicom Sinicum. Botanical Investigation into the Materia Medica of the Ancient Chinese, III. *Roy. Asiatic Soc. of Great Britain and Ireland, N. China Branch, Shanghai Jour.*, (n. s.) 16:79 (*Salisburia*)
- Bretschneider, E. 1898. History of European Botanical Discoveries in China. London, *Sampson, Low, Marston*; 2 vols. Ginkgo: p. 709.
- Brizi, U. 1948. Some further notes on *Ginkgo biloba*. *Roy. Hort. Soc. Jour.*, 73:328-331.
- Brockman, C. F. 1952. Story of the Petrified Forest. Ginkgo State Park. Takoma, Wash., *Northern Pacific Bank Note Co.*, 16p.
- Brown, H. P., and Panshin, A. J. 1940. Commercial timbers of the United States. New York and London, *McGraw-Hill*, 554p. Ginkgo: p. 6, 7.
- Brown, R. W. 1937. Fossil Plants from the Colgate member of the Fox Hills Sandstone and Adjacent Strata. *U. S. Geol. Survey Prof. Paper* 189-1, p. 246-247.
- Brown, R. W. 1943. Some prehistoric trees of the United States. *Jour. Forestry*, 41:861-868.
- Brush, W. D. 1947. *Ginkgo. Amer. Forests*, 53(10):460-461.
- Bucholz, J. 1806. Notice sur le *Ginkgo* au Noyer du Japan. In his Dissertation sur le Cedre du Liban, etc. p. 87-90.
- Bucholz, V. 1932. Der "fächerblätterbaum" *Ginkgo biloba* L. als strassenbaum. *Gartenfl.*, 81:241-244.
- Bulard, C. 1952. Culture aseptique d'embryons de *Ginkgo biloba*. Role des cotyledons dans l'absorption du sucre et la croissance de la tige.

Acad. des. Sci. Compt. Rend., 235:739-741.

Buvat, R. 1948. Recherches sur les effets cytologiques de l'eau. *Rev. Cyt. et Cytophys. veget.*, 10:1-35.

Cahen, E. 1943. The Ginkgo through the Ages. *Roy. Hort. Soc. Jour.*, 68:99-105.

Cahen, E. 1947. *Ginkgo biloba* L. *Roy. Hort. Soc. Jour.*, 72:288.

Camefort, H. 1951. Structure du point vegetatif de *Ginkgo biloba* en periode d'activite (initiation foliaire). *Acad. des Sci. Comp. Rend.*, 233:88-90.

Camefort, H. 1956. Etude de la structure du point vegetatif et des variations phyllo-taxiques chez quelques gymnosperms. *Ann. Sci. Nat. Bot.*, 17(1):1-185.

Biol. Abst., 11815. Apr. 1957.

Camp, W. H. 1947. Distribution Patterns in Modern Plants and the Problems of Ancient Dispersals. *Ecological Monographs*, 17:182.

Campbell, D. 1940. Evolution of the Land Plants [Embryophyta], Stanford, Cal., *Stanford Univ. Press*, 731P. Ginkgo: p. 32, 436, 440, 441, 450, 452, 454, 460, 474-480, 481.

Campbell, W. 1949. Ancient trees of Kew Gardens, *Ginkgo biloba*. *Trees*, 10(1):11-16.

Cappelletti, C. 1940. Sulla sopravvivenza di radici di *Ginkgo biloba* nel terreno dopo l'abbattimento del fusto. *Nuovo Giorn. Bot. Ital.*, (n.s.) 47:527-530.

Carothers, I. 1907. Development of the ovule and female gametophyte in *Ginkgo biloba*. *Bot. Gaz.* 42:116-130.

Carriere, E. A. 1854. Notice sur le *Torreya myristica* et sur de nouvelles varietes du *Salisburia adiantifolia* ou *Ginkgo biloba*. *Rev. Hort.*, ser. 4, 3:412-413.

Carruth, M. I. 1940. The quest for "lost" plants is kept up by the botanists. *The New York Times*, Feb. 25.

Cavara, F. 1924. Fecondazione a distanza in *Ginkgo biloba* Linn. e in *Araucaria bidevilli* Hook. *Boll. Soc. Nat. Napoli*, CE (Comm. Verbali):3-5.

Celanovsky, L. J. 1900. Die Vermehrung der Sporangia von *Ginkgo biloba* L. in *Ost. Bot. Zietchr.*, 50:229-236, 276-283, 337, 341.

Ceruti, A. 1947a. Clorocondrioma e cromocondrioma isolata in vitro. *Lavori Bot. Torino*, 8:77-94.

- Ceruti, A. 1947b. Isolamento in vitro di un cloro- e di un chromocondrioma. *Atti. Accad. Lincei Rend. Cl. Sci. Fis. Mat. e Mat.*, Ser. 8A, 2(6):828-829.
- Ceruti, A. 1947c. Sul indrazione delle lignine in rapporto alla sua specificita. *Nuovo Giorn. Bot. Ital.*, 54(1/2):371-372.
- Ceruti, A. 1948. L'azione di alcuni cationi e dell 'acqua sul chondrioma isolata in vitro. *Atti. Accad. Lincei Rend. Cl. Sci. Fis. Mat. e Mat.*, Ser 8A 5(6):452-460.
- Chadwick, L. C. 1951a. The demand outlook for shade trees New and Old. *Trees*, 11(6):8-21.
- Chadwick, L. C., Miller, R. R. and Erskine, D. 1951b. Prevention of fruit formation on some ornamental trees. *Amer. Soc. Hort. Sci. Proc.*, 58:308-312.
Chem. Abst., 8798C 1952.
- Chamberlain, C. J. 1898. The homology of the blepharoplast. *Bot. Gaz.*, 26:431-435.
- Chamberlain, C. J. 1916. (On Cycads). *Bot. Gaz.*, 50:417-418; 53:16; 61:362.
- Chamberlain, C. J. 1935. Gymnosperms, Structure and Evolution. Chicago, *Univ. Chicago Press*, 484p. Ginkgo: p. 191-193.
- Chaney, R. W. 1940. Tertiary Forests and Continental History. *Geol. Soc. Amer. Bull.*, 51:473.
- Chaney, R. W. 1944a. Pliocene Floras of California and Oregon. *Carnegie Inst. of Washington*, p. 311.
- Chaney, R. W. 1944b. Trees and History. Sci. in the Univ., 75th Anniv. vol., *Univ. of California*, p. 252.
- Chaney, R. W. 1947. Tertiary centers and migration routes. *Ecol. Monographs*, 17:139-148.
- Cheng, W. C. 1933. Enumeration of gymnosperms of 20 species of Cycas, Ginkgo, and Coniferae. *Biol. Lab. Sci. Soc. China Bot. Ser. Contr.*, 8(3):3.
- Cheng, W. C. and Chien, C. S. 1933. An enumeration of vascular plants from Chekiang I. *Biol. Lab. Sci. Soc. China Bot. Ser. Contr.* 8:298-306.
- Chien, H. 1921. Chinese Economic Trees. Shanghai, *Commercial Press*, China, 309p. Ginkgo: p. 1-3.

- Chou, H. F. 1934. Familiar Tress of Hopei. Handbook 4; *Fan Mem. Inst. of Biol. Nat. Hist. Bull.*, Peiking, 370p. Ginkgo: p. 14-17.
- Chow, H. F. 1934. see Chou, H. F.
- Chun, W. Y. 1921. see Chien, H.
- Claxton, T. B. 1940. *Ginkgo biloba* in Kentucky. *Trees*, 3:8.
- Clemenceau, 1868. *Ginkgo biloba* a feuille panachee. *Rev. Hort.*, 40:360.
- Cleveland Shade Tree Census, 1939. Cleveland. p. 43.
- Collingwood, G. H. and Brush, W. 1947. Knowing Your Trees. *Washington, D. C. Amer. Forestry Assn.* 312p. Ginkgo: p. 304-305.
- Collins, G. N. 1903. Dimorphism in the shoots of the Ginkgo. *Plant World*, 6:9-11.
- Cook, M. T. 1902. Polyembryony in *Ginkgo*. *Bot. Baz.*, 34:64-65.
- Cook, M. T. 1903. Polyembryony in *Ginkgo*. *Bot. Gaz.*, 36:142.
- Cooper, D. C. 1952. The transfer of desoxyribose nucleic acid from the tapetum to the microsporocytes at the onset of meiosis. *Amer. Nat.*, 86:219-229.
- Corbett, L. C. 1903. The Japanese Ginkgo makes a fine avenue tree. The avenue at Washington, D. C. is thirty years old. *Amer. Gard.* 24:587-588.
- Corsa, W. P. 1896. Nut culture in the United States. *U. S. D. A. Div. of Pomology, Special Rept.*, p. 144.
- Coulter, J. M. 1898. Origin of Gymnosperms and the Seed Habit. *Bot. Gaz.*, 26:153-168.
- Coulter, J. M. and Chamberlain, C. J. 1910. Morphology of Gymnosperms. Chicago, *Univ. of Chicago Press*, 458p. Ginkgo: p. 185-219.
- Crittenden, H. F. 1932. Conifers in Cultivation, Report of Conifer Conference, *Roy. Hort. Soc.*, 1931, p. 81.
- Dallimore, W. 1922. The fruiting of *Ginkgo biloba* at Kew. *Kew Roy. Bot. Gard. Bull. Misc. Inform.* p. 262-265.
- Dallimore W. and Jackson, A. B. 1923. A handbook of Coniferae including Ginkgoaceae. New York, *Longmans Green*, 570p. Ginkgo: p. 543-547.
- Dangeard, P. 1920. Evolution of a vascular system in Gymnosperms. *Acad. des Sci. Comp. Rend.*, 170(8):474-477.
- Dangeard, P. 1946. Sur le moment de la fecondation chez le Ginkgo. *Soc.*

Bot. de France Bull., 93:19-20.

- Durrah, W. C. 1939a. Principles of Paleobotany. Leiden, Holland, *Chronica Botanica Co.*, 239p. *Ginkgos* p. 129-131, 176, Chapt. XIII Gingoales.
- Durrah, W. C. 1939b. Textbook of Paleobotany. Cambridge, *Harvard Univ. Press*, 441p. *Ginkgo*: p. 12, 207.
- Davis, S. H. Jr. and Harry, J. B. 1942. A *Xylaria* pathogenic to *Ginkgo biloba* L. seeds. *Phytopathology*, 31(1):91-93.
Biol. Abst. 10866. 1942.
- De Bary, A. 1884. Comparative Anatomy of the Vegetative Organs of the Phanerogams and Ferns. Oxford, *Clarendon Press*, 659 p. *Ginkgo*: p. 14, 204, 345, 246, 301, 379, 382, 443, 552, 561, 566.
- DePape, G. et Borel, A. 1954. Un *Ginkgo biloba* L. femelle fertile a Lille. *Bull. Ste. Bot. du Nord de la Fr.*, 7:23-26.
- Desfontaines, R. 1829. Catalogus plantarum. Paris, *J. S. Chaude*, 460p. *Ginkgo*: p.357.
- Delisle, A. 1939. Further studies on the vegetative propagation of some gymnosperms, with Indole Acetic acid. *Amer. Jour. Bot.*, 26(10):22s.
- Dern, H. F. 1836. Bemerkung uber einen Aufsatz von Herrn Raffineau-Delile zu Montpellier wegen *Ginkgo biloba* oder *Salisburia adiantifolia* Allg. *Gartenzeit*, 4:131-134.
- Dern, H. F. 1838. Bemerkung uber einen Aufsatz von Herrn Raffineau-Delile zu Mon Montpellier wegen *Ginkgo biloba* oder *Salisburia folia*. Allg. *Gartenzeit*, 6:189-190.
- Detwiler, S. 1938. The Ginkgo—A Street Tree Today; a Hillculture Possibility Tomorrow. *Soil Conservation*, 4(5):122-124.
- Dippel, L. 1862. Zur Histologie der coniferen. *Bot. Zeitschr.*, 20(22):169-174.
- Doran, W. 1954. Vegetative propagation of Ginkgo. *Jour. Forestry*, 52:176-177.
- Dorf, E. 1955. Plants and the geologic time scale (In the Crust of the Earth). *Geol. Soc. Amer. Spec. Pap.*, 62:586-589.
- Dorf, E. 1958. The Geological Distribution of the Ginkgo Family. *Wagner Free Inst. Bull.*, 33(1), 10 p.
- Drahowzal, G. 1936. Beitrag zur Morphologie and Entwicklungsgeschichte

- der Pollenkomer. *Oesterreich. Bot. Zeitschr.*, 85(4):241-296. *Biol. Abst.*, 7022. 1937.
- Eames, A. J. 1955. The seed and Ginkgo. *Jour. Arnold Arboretum*, 36:165-170.
- Egberts, H. 1955. Outbladering van boomwekerijgewassen met chemische middelen. *Jaarb. Proefst. Boomkw. Boskoop.*, Ginkgo: p. 122-124.
- Eichler, A. N. 1863. Dans "Martius Flora Brasiliensis." *Monaco* 4(1):423.
- Eichler, A. N. 1889. *Ginkgo* Kampf. Die Natürlichen Pflanzenfamilien (by A. Engler and K. Prantl). Leipzig, W. Englemann, 2(1):262.
- Eichorn, A. 1928. Sur la mitose somatique et le satellite du *Ginkgo b. Soc. Biol. Compt. Rend.*, 99(36):1787-1788.
- Eichorn, A. 1931. Recherches caryologiques comparees chez les Angiosperms et les Gymnosperms. *Arch. Bot.*, 5:1-93.
- Emberger, L. 1942. L'homologie des organes reproducteurs femelles de *Ginkgo biloba*. *Soc. Bot. de France. Bull.*, 89:243-244.
- Emberger, L. 1942. Sur les Pteridospermees et les Cordaitales. *Soc. Bot. de France Bull.*, 89:202-203.
- Emberger, L. 1944. Les Plantes Fossiles dans leurs Rapports avec Les Vegetaux Vivants. Paris, *Masson et Cie Libraires de l'Academie de Medecine*, 492p. *Ginkgo*: p. 35, 276, 282, 359, 361, 367, 376, 406, 460; *Ginkgoales*: p. 37, 39, 40, 41, 340, 359, 363, 380, 406, 407, 409, 410, 424, 444, 445, 447, 448, 449, 464.
- Emberger, L. 1949. La position systematique de *Ginkgo biloba*. *Acad. des Sci. Compt. Rend.*, 229:960-963.
- Embrey, H., and Wang, T. C. 1921. Analyses of Some Chinese Foods. *Chinese Medical Jour.*, 35:247-257.
- Chem. Abst.*, 16, no. 1467. 1922.
- Endlicher, S. 1836. Genera plantarum I secundum ordines naturales disposita Vindobonae. *Fredericum Beck*, 1483p. *Ginkgo*: p. 262, no. 1803 as *Salisburia*.
- Endlicher, S. 187. Synopsis Coniferarum (in Latin), 368p. (as *Salisburia* in Taxineae). Sangali, *Scheitlin Zollikofer*, 368p. *Ginkgo*: p. 236-237.
- Engler, A. 1897. Ginkgoaceae von A. Engler. *Die natürlichen pflanzenfamilien, begr. von A. Engler und K. Prantl*. Leipzig. Nachtrage z. II.-IV. t. p. 19-20.
- Erdtman, G. 1943. An Introduction to Pollen Analysis. Waltham, Mass.,

Chronica Bot., 239p. Ginkgo: p. 132, 133.

- Erwin, A. T., and Baker, H. P. 1907. Evergreens for the Iowa planter. *Iowa Agr. Expt. Sta. Bull.*, 90:46.
- Ewart, A. J. 1908. On the Longevity of Seeds. *Roy. Soc. Victoria Proc.*, 21.
- Fairchild, D. 1938. The World was My Garden. New York and London, *Scribner's*, 494p. Ginkgo: p. 99.
- Faun, M. 1945. Studies on the influence of several substances upon the production of precipitines. *Formosan Med. Assn. Jour.*, 44(4):5-35.
- Favre-Duchartre, M. 1943. Sur le comportement des ovules de *Ginkgo biloba*. *Soc. Bot. de France Bull.*, 90:111-116.
- Favre-Duchartre, M. 1945. Polyprothallie chez *Ginkgo biloba*. *Soc. Bot. Bull.*, 92:26-28.
- Favre-Duchatre, M. 1950a Contribution a l'etude de la fecondation et du developpement syncytial du proembryon chez *Ginkgo biloba*. *Acad. des Sci. Compt. Rend.*, 230:569-570.
- Favre-Duchartre, M. 1950b. La reaction de Feulgenan au cours de la gametogenese chez *Ginkgo biloba*. *Acad. des Sci. Compt. Rend.*, 230:404-406.
- Favre-Duchartre, M. 1956. Contribution a l'etude de la reproduction chez le *Ginkgo biloba* L. *Rev. de Cyt. Biol. Veg.*, p. 1-214.
- Felt, E. P. 1940. Nature's Report on Shade Trees. *Flow. Grow.*, 27(6):277.
- Fernow, B. 1911. Care of Trees in lawn, street and park with a list of trees for decorative use. New York, *Henry Holt*, 392p. *Ginkgos* p. 209, 213, 226.
- Fischer, H. 1949. Plasmolyseform and Mineralsalzgehalt in alterndern Blättern II Untersuchungen au Land and Schwimmpflanzen. *Planta*, 37(2):244-292.
- Biol. Abst.*, 13485. 1950.
- Florin, R. 1935. Anatomy of the leaves and dwarf shoots in Mesozoic ginkgophyta. *Int. Bot. Cong. Proc.*, 2:235-237.
- Florin, R. 1936a. Die fossilen Ginkgophyten von Franz Joseph Land, nebst Erortung uber vermeintliche Cordaitales mesozoischen Alters. I. *Spezieller Teil. Palaeontographica*, 81(B):1-173, 11-42.
- Florin, R. 1936b. Die fossilen Ginkgophyten von Franz Joseph Land, nebst Erortung uber vermeintliche Cordaitales mesozoischen Alters. II. *Allgemeiner Teil. Palaeontographica*, 82(B):1-72, pl. 1-6.

- Florin, R. 1937. On A. C. Seward, The Geological History of the Maiden-hair Tree and its Allies. *Nature Mag.*, 139:741-745.
- Fortune, R. 1847. Three years wanderings in the northern provinces of China. London: *John Murray*. 440p.
- Fortune, R. 1857. A residence among the Chinese. London: *John Murray*. 440p.
- Foster, A. 1920. The fruiting of the Ginkgo at Kew. *Kew Roy. Bot. Gard Bull., Misc. Inform., Ginkgo*: p. 47-48.
- Foster, A. 1938. Structure and Growth of the Shoot Apex in *Ginkgo biloba*. *Torrey Bot. Club Bull.*, 65:531-556.
Biol. Abst., 16796. 1938.
- Francis, W. 1954. Coal: Its formation and composition. London: *E. Arnold*. 567 *Ginkgo*: p. 19, 78, 103.
- Freund, H. 1921. Goethe und die Ginkgo. *Deut. Dendrologischen Gesell. Mitt.*, 31:312-313.
- Fujii, K. 1895. On the nature and origin of the so-called "chi-chi" (nipples) of *Ginkgo biloba* L. *Bot. Mag. Tokyo*, 9:444-450.
- Fujii, K. 1896. On the different views hitherto proposed regarding the morphology of the flowers of *Ginkgo biloba* L. (in Japanese). *Bot. Mag. (Tokyo)*, 10:8-9, 13-15, 104-109.
- Fujii, K. 1898. Has the spermatozoid of *Ginkgo* a tail or not? (in Japanese). *Bot. Mag. (Tokyo)*, 12:287-290.
- Fujii, G. 1899. Observations on the morphology of the pollen tube and the spermatozoid of *Ginkgo*. *Bot. Mag. (Tokyo)*, 13:28-30.
- Furuichi, M. 1927. On physical and chemical properties of various proteins in the nuts of *Ginkgo biloba* L. (in Japanese with English summ.). *Tott. Soc. Agri. Sci.*, 1(2):123.
- Furuichi, M. 1928. Physiochemical study of proteins contained in the ginkgo. *Tott. Higher Agr. Schol Bull.*, 1:105-122.
Chem. Abst., 2196(7). 1929.
- Furukawa, S. 1932a. Constituents of *Ginkgo biloba* L. Leaves I. *Inst. Phys. and Chem. Res. Tokyo Sci. Papers Bull.*, 19:27-39.
- Furukawa, S. 1932b. Constituents of *Ginkgo biloba* L. Leaves II. *Inst. Phys. and Chem. Res. Tokyo Sci. Papers Bull.*, 19:39-42.
- Furukawa, S. 1933a. Constituents of *Ginkgo biloba* L. Leaves III. *Inst. Phys. and Chem. Res. Tokyo Sci. Papers Bull.*, 21:273-277.

- Furukawa, S. 1933b. Constituents of *Ginkgo biloba* L. Leaves IV. *Inst. Phys. and Chem. Res. Tokyo Sci. Papers Bull.*, 21:278-285.
- Furukawa, S. 1934a. Studies on constituents of *Ginkgo biloba* fruits I. *Inst. Inst. Phys. and Chem. Res. Tokyo Sci. Papers Bull.*, 24:314-319.
- Furukawa, S. 1934b. Studies on constituents of *Ginkgo biloba* fruits II. *Inst. Phys. and Chem. Res. Tokyo Sci. Papers Bull.*, 24:304-313.
- Furukawa, S. 1934c. Studies on constituents of *Ginkgo biloba* fruits III. *Inst. Phys. and Chem. Res. Tokyo Sci. Papers Bull.*, 24:319-333.
- Gale, E. 1945. Tree of another Age. *Horticulture*, 23:55-56.
- Gatenby, E. 1944. A further note on the name Ginkgo. *Roy. Hort. Soc. Jour.*, 69:308-309.
- Gaussen, H. 1946. Les Gymnospermes actuelles et fossiles. *Trav. Lab. Toulouse*, Fasc. 3, Les Ginkgoales. Ginkgo: p. 1-54.
- Geyler, H. T. 1867. Ueber den Gefassbündelverlauf in den Laubblattregionen der Coniferen. *Prigsb. Jahrb. f. Wiss. Bot.*, 6:55-103.
- Gilliland, F. 1947. The Conifers at Mt. Usher Co., Wicklow. *Roy. Hort. Soc. Jour.*, 72:237.
- Goebel, K. 1932. Organographic der Pflanzen. Jena; G. Fisher, 838p. Ginkgo: p. 699.
- Goff, E. S. 1894. Notes on ornamental trees and shrubs. *Wisconsin Agri. Expt. Sta. Rept.*, p. 340-342.
- Gopal-Ayengar, A. R. 1942. Structure and behavior of meiotic chromosomes in Gymnosperms. *Genetics*, 27(1):143. *Biol. Abst.*, 8691. 1942.
- Goroshankin, J. N. 1883. Zur Kenntnis der Corpuscula bei den Gymnospermen. *Bot. Zeitscher.*, 41:825-831.
- Gourlay, W. 1952. A fruiting maidenhair tree [*Ginkgo biloba*]. *Gard. Chron.*, 131:6.
- Graebner, L. 1894. Samen an *Ginkgo biloba*. *Gartenfl.*, 43:642.
- Graham, R. J. D., and Stewart, L. B. 1929. Vegetative Propagation of Leaf Cuttings in Gymnosperms. *Bot. Soc. Edinburgh Trans. and Proc.*, 30(2):67-69.
- Green, E. 1946. *Ginkgo biloba*. *Nat. Hort. Mag.*, 25:409.
- Green, S. B. 1892. Ornamental and timber trees, shrubs and vines.

Minnesota Agri. Expt. Sta. Bull. 24:173-208, 214-222.

- Greguss, P. 1929. A *Bryonia dioica* és a *Ginkgo biloba* levelei nek sexualis dimorphizmusa. (in Hungarian). *Mat. Termeszett Ertesito Magyar Tud. Akad. Budapest*, 46:625-631.
- Greguss, P. 1955. Identification of Living Gymnosperms on the Basis of Xylotomy. Budapest: *Akad. Kiado*, 350p. Gingo: p. 263.
- Griebel, C. 1939. Beitrage zur kenntnis der ginkgosamen. *Deut. Apoth-Zeit.*, 54:603-608.
Chem. Abst., v. 33, 7484/6.
- Grier, N. M. 1917. Sexual dimorphism and variation in *Ginkgo biloba* L. *Torrey*, 17(12):225.
- Grove, W. B. 1935. British stem and leaf fungi (Coelomycetes), a contribution to our knowledge of the Fungi Imperfecti belonging to the Sphaeropsidales and Melanconiales which have colorless or nearly colorless spores. Cambridge, Eng. *Cambridge Univ. Press*, 488p. *occulta* v. *ginkgoina*: p. 179.
Biol. Abst., 4178, 1936.
- Gulliermond, A. 1937. Sur la presence de lipides (Phospho-lipides et Sterides) dans les vacuoles de certaines cellules vegetales. *Protoplasma*, 27:290-307.
- Gunckel, J. E. 1942. Certain dynamic aspects of shoot growth in *Ginkgo*. *Amer. Jour. Bot.*, 29(10):10 p.
- Gunckel, J. E., 1947. Studies of the development in long shoots of *Ginkgo biloba* L. Harvard Univ. Grad. School Arts and Sci. Sum. 1943/45: 75-78. 1947 thesis.
- Gunckel, J. E., and Wetmore, R. H. 1946a. Studies of development in long shoots and short shoots of *Ginkgo biloba* L. I. The origin and pattern of development of the cortex, pith and procambium. *Amer. Jour. Bot.*, 33(4):285-295.
- Gunckel, J. E., and Wetmore, R. H. 1946b. Studies of development in long shoots and short shoots of *Ginkgo biloba* L. II Phylotaxis and the organization of the primary vascular system. *Amer. Jour. Bot.*, 33(6): 532-543.
- Gunckel, J. E., and Thimann, K. V. 1949a. Studies of the development in long shoots and short shoots of *Ginkgo biloba* L. III. Auxin production in shoot growth. *Amer. Jour. Bot.*, 36(2):145-151.
- Gunckel, J. E., and Thimann, K. V., and Wetmore, R. H. 1949b. Studies of development in long shoots and short shoots of *Ginkgo biloba* L. IV.

Growth habit, shoot expression and mechanism of its control. *Amer. Jour. Bot.*, 36(3):309-316.

Gunckel, J. E., and Sparrow, A. H. 1953. Aberrant growth in plants induced by ionizing radiation. *Brookhaven Symposia in Biol.*, 6:252-279. *Biol. Abst.* 1774. 1955.

Hadfield, M. 1950. Cuttings of deciduous conifers. *Roy. Hort. Soc. Jour.*, 75(12):487.

Hanbury, D. 1876. Notes on Chinese Materia medica. Scientific Papers, London: Macmillan, 543p. Ginkgo: p. 234.

Harris, T. M. 1937a. The fossil flora of Scoresby Sound, east Greenland. Part 4. Ginkgoales, Coniferales, Lycopodiales and isolated fructifications. *Medd. om Gronland*, 112(1):1-176, pl. 1-29.

Harris, T. M. 1937b. The fossil flora of Scoresby Sound, east Greenland. Part 5, Stratigraphic relations of the plant beds. *Medd. om Gronland*, 112(2):1-114.

Harris, T. M. 1948. Notes on the Jurassic Flora of Yorkshire 37-39. *Ann. and Mag. Nat. Hist.*, 12th Ser., 1(3):181-213. *Biol. Abst.*, 17941. 1951.

Hartzell, A., and Wilcoxon, F. 1941. A survey of plant products for insecticidal properties. *Boyce Thompson Inst. Contr.*, 12:131.

Hase, A. 1955. Ueber insektenschaden an *Ginkgo biloba* L. *Ghent Landbouwhogeschool Mededelingen*, 20:331-336.

Hasegawa, M., Nakamura, H., and Tsurumo, S. 1955. Flavonoids from the leaves of gymnosperms. I. Catechin and flavonoids in the leaves of *Chamaecyparis pisifera*. *Jap. Forestry Soc. Jour.*, 37:488-491.

Hatano, K., and Kano, T. 1952. A brief report on the after-ripening of the seeds of *Ginkgo biloba* (in Japanese). *Jap. Forestry Soc. Jour.*, 34(12):369-370.

Hatano, K. 1953. On the Amino Acids in the Seeds and Seedlings of *Ginkgo biloba*. *Bull. Tokyo Univ. Forests*, 44:221-227.

Hatano, K. 1955. Free amino acids in the ripening *Ginkgo biloba* Seed. (in German). *Jap. Forestry Soc. Jour.*, 37:527-529.

Heal, R. H. 1950. A Survey of Plants for Insecticidal Activity. *Lloydia*, 13(2):89-164.

Heer, O. 1881. Zur Geschichte der Ginkgoartigen Baume. *Engler's Bot. Jahrb.*, Leipzig, 1:1-13

Heinricher, E. 1927. Ein anschauliches beispiel fur die stetigkeit indi-

vidueller eigenschaften. *Deut. Bot. Gesell. Ber.*, 45:207-210.

- Henkel, J. B., and Hochstetter, W. 1865. Synopsis der Nadelholzer. Stuttgart. *J. G. Cottaschen*, 446p. Ginkgo: p. 373.
- Henry, A. 1906. *Ginkgo biloba*, maidenhair tree, in Elwes and Henry, Trees of Great Britain and Ireland. Edinburgh: Privately printed. 1:56-62.
- Henry, M. L. 1898. Caracteres secondaires distinctifs des deux sexes chez le *Ginkgo biloba*. *Assoc. Anciens Eleves Ecole Hort. Versailles Bull.*, Ginkgo: p 592.
- Henry, M. L. 1899a. Caracteres secondaires distinctifs des deux sexes chez le *Ginkgo biloba*. *Soc. Nat. Hort. France Jour.*, 3 ser. 21.
- Henry, M. L. 1899b. Distinctive characteristics of the sexes of *Ginkgo biloba*. cited in *Gard. Chron.*, 3 ser. 25 (640):201.
- Herrick, G. W. 1935. Insect Enemies of Shade Trees. Ithaca, New York: Comstock, 417p. Ginkgo insects: p: 105.
- Herzfeld, S. 1926. Neue beitrage zur kenntnis des befruchtungevorganges von *Ginkgo biloba*. *Vorlaufige mitt. Oester. Bot. Zeitschr.*, 75:158-161.
- Herzfeld, S. 1927. Beitrage zur Kenntnis von *Ginkgo*. *Jahrb. Wiss. Bot.*, 66:814-862.
- Herzfeld, S. 1928a. Nachtrag zu meiner arbeit "Beitrage zur Kenntnis von Ginkgo." *Jahrb. Wiss. Bot.*, 67(5):981.
- Herzfeld, S. 1928b. Ueber die Kernteilungen im Proembryo von *Ginkgo biloba* L. *Jahrb. Wiss. Bot.*, 69:265-293.
- Hildebrand, F. 1860. Der Bau der Coniferenspaltöffnungen und einige Bemerkungen uber Verteilungen derselben. *Bot. Zeitung*, 18(17):149.
- Hilpert, R., and Pfutzenreuter, J. 1938. Characterization of the plant cell wall by treatment with copper oxide-ammonia solution. *Deut. Chem. Gesell. Ber.*, 71B:2220-2222.
- Chem. Abst.*, v. 33:8539, 1939. col. 1-4464.
- Hilpert, R. S., and Knalstedt, W. 1939. Composition of the Plant Cell Wall. II. The bast fibers of tree barks. *Deut. Chem. Gesell. Ber.*, 72B:1582-1588.
- Hirase, S. 1894a. Fecundation period of *Ginkgo biloba*. (in Japanese). *Bot. Mag. (Tokyo)*, 8:7-9.
- Hirase, S. 1894b. Notes on the attraction spheres in the pollen cells of *Ginkgo biloba*. *Bot. Mag. (Tokyo)*, 8:359-360.

- Hirase, S. 1895a. Etudes sur le *Ginkgo biloba*. *Bot. Mag.* (Tokyo), 9:239-240.
- Hirase, S. 1895b. Etude sur la fecondation et l'embryogenie du *Ginkgo biloba*. *Tokyo Imp. Univ. Col. Sci. Jour.*, 8:307-322.
- Hirase, S. 1896. On the spermatozoid of *Ginkgo biloba*. (in Japanese). *Bot. Mag.* (Tokyo), 10:325-328.
- Hirase, S. 1897. Untersuchungen uber das Verhalten des Pollens von *Ginkgo biloba*. *Bot. Centralblatt*, 69:33-35.
- Hirase, S. 1898. Etudes sur la fecondation et l'embryogenie du *Ginkgo biloba*. *Tokyo Imp. Univ. Col. Sci. Jour.*, 12(2):103-149.
- Hirase, S. 1918. Nouvelles recherches sur la fecondation et l'embryo-genie du *Ginkgo biloba*. *Bot. Mag.* (Tokyo), 32:139-143.
- Hirata, T. 1939. Forest Fires in Japan. *Tokyo Dept. Forestry, Ministry of Agr. and Forestry*, 21p. *Ginkgo*: p. 8.
- Howe, H. J. 1942. Our common trees and how to know and use them. *Maryland Nat. Hist. Soc.*, Baltimore, 98p. *Ginkgo*: p. 86, 87.
- Ikeno, S. and Hirase, S. 1897. Spermatozoids in Gymnosperms. *Ann. Bot.* 11:344-345.
- Ikeno, S. 1901. Contribution a l'etude de la fecondation chez le *Ginkgo biloba*. *Ann. Sci. Nat. Bot.*, Ser. 8, 13:304-318.
- Ikeno, S. 1904. Blepharoplasten im Pflanzen Reich. *Biol. Centralblatt*, 24:211-221.
- Ikuse, M. 1955. General List of pollen grains in Japan. (in Japanese with English summary). *Jap. Jour. Bot.*, 30(2):45-55.
- Illick, J. T. 1941. Chromosomes of *Ginkgo biloba* during early development stages of the male gametophyte. *Anat. Rec.*, 81:78:79. *Biol. Abst.*, 11560, 1942.
- Ioue, Y., and Moda, M. 1950. Paper partition chromatography of aliphatic carboxylic acids by means of hydroxamic acid method. *Agr. Chem. Soc. Japan Jour.*, 23:368.
- Ishikawa, M. 1910. Ueber die Zahl der Chromosomen von *Ginkgo biloba* L. *Bot. Mag.* (Tokyo), 24:225-226.
- Ishimaru, K. 1946. Distribution of ascorbic acid oxidase in plants. *Shokunjo no Kagaku* (Sci. of Foods), 1:77-78.
- Jackson, A. B. 1946. The identification of conifers. London: *E. Arnold*, 152p. *Ginkgo*: p. 146.

- Jacques, A. 1836. Note sure le Ginkgo femelle, *Salisburia adiantifolia* foemina. *Soc. Hort. Paris Ann.*, 18:374-375.
- Jacques, A. 1857. Flore des Jardins de l'Europe. Paris: *Lib. Agr. de la Maison Rust.* 1094p. Ginkgo: p. 306.
- Jacquín, N. J. von. 1819. Ueber den *Ginkgo*. *Jahrb. Med. Oesterr.*
- Jaffa, M. E. 1908. Nuts and their Uses as Food. *U. S. D. A. Farmer's Bull.*, 332:9.
- Jeffrey, E. C., and Torrey, R. E. 1916. *Ginkgo* and the microsporangial mechanisms of the seed plants. *Bot. Gaz.*, 62:281-292.
- Jeffrey, E. C., and Wetmore, R. H. 1926. On the occurrence of parichnos in certain conifers. *Ann. Bot.*, 40:799-811.
- Johnson, G. W. 1944. The Ginkgo—The Story of a Living Fossil. *Canadian Hort. and Home Mag.*, 67:12-18.
- Just, T. 1948. Gymnosperms and the Origin of Angiosperms. *Bot. Gaz.*, 110(1):91-103.
- Kaempfer, E. 1712. *Amoenitatum exoticarum. Lemgoviae* fasc. 5:811.
- Kanehira, K. 1926. Anatomical Characters and Identification of Most Important Woods of Japanese Empire. Taikoku, Formosa: *Govt. Research Inst., Dept. of Forestry*, 297p.
- Karsten, H. 1865. *Gesammelte Beiträge zur Anatomie und Physiologie der Pflanzen*. Berlin: *R. Friedländer*. Ginkgo: p. 192.
- Karstens, W. K. H. 1945. Variability of the Female Reproductive Organs in *Ginkgo biloba* L. *Blumea*, 5:532-553.
- Karstens, W. K. H. 1955. Observations on the proliferation of stem pith parenchyma in vitro. I. General Introduction. *Acta. Bot. Neerlandica*, 4(2):183-187.
- Biol. Abst.*, 23953. 1956.
- Kasanaga, H. and Mosnsi, M. 1954. The light transmission of leaves and its meaning for the production of matter in plant communities. (in English). *Jap. Jour. Bot.*, 14:304-324.
- Kawamura, J. 1928a. Über die chemischen Bestandteile der Frucht von *Ginkgo biloba* L. *Jap. Jour. Chem.*, 3(2):89-108.
- Kawamura, J. 1928b. Über die chemischen Bestandteile der Frucht von *Ginkgo biloba* L. *Ringyo Shikenhokoku*, 28:127-156.
- Keener, P. D. 1950. Microflora of buds—Results of cultures from non-

irradiated materials of certain woody plants. *Amer. Jour. Bot.*, 37 (7); 520-527.
Biol. Abst., 6247. 1951.

Kircheimer, F. 1945. Beitrag zur Morphologie der Samen von *Ginkgo biloba* L. *Soc. Bot. Suisse Bull.*, 55:304

Knowlton, F. H. 1927. Plants of the Past. Princeton: *Princeton Univ. Press*, 275p. *Ginkgo*: p. 140.

Koch, K. 1855. Geschichtliches uber die Verbeitung des Ginkgobaumes. *Ver. Beford. Gartnb. Preuss. Verb.*, ser. 2 (1854) pt. 2:6. 8-15.

Koch, K. 1856. Geschichtliches uber die Verbeitung des Ginkgobaumes. *Deut. Mag. Gartenb. Blumenk.* p. 29-28.

Koidzumi, G. 1936. Old records of *Ginkgo* in China. (in Japanese). *Act. Phytotax. Geobot.*, 5:263-264.

Korea. 1928. Forestal Exp. Sta., Method of identification by seeds of principal forest trees of Japan. (in Japanese). *Its. Bull.*, 8. *Ginkgo*: p. 54, pl. III.

Koshimizu, T. 1940a. Various forms of the seed of *Ginkgo biloba* L. *Jap. Jour. Bot.*, 10(9):551-552.

Koshimizu, T. 1940b. Various forms of the seed of *Ginkgo biloba* L. *Plant Sci. Lit.*, 12(19):10.

Kristofovich, A. 1938. Nazvanie *Ginkgo* v nauchnow literature. (in Russian). *S. S. S. R. Bot. Thurn.*, 23:193-208.

Kuwada, Y., and Maeda, T. 1929. On the structure of the cytoplasm around the blepharoplast in *Cycas revoluta*. *Num. Col. Sci. Kyoto Imp.*, Ser. B 4(3):165-174.
Biol. Abst., 10792, 1930.

Lamb, F. H. 1938. *Sagas of the Evergreens*. New York: W. W. Norton, 351p. *Ginkgo*: p. 17, 21, 26, 30, 32, 36-45, 115, 116.

Lange, J. H. *Ginkgo* or *Ginkgo*? *Amer. Forests*, 45(5):242.

Langley, R. W. 1907. Composition of Some Edible Seeds from China. *Amer. Chem. Soc. Jour.*, 29:1513-1515.

Lee, C. L. 1943. Reproductive morphology of *Ginkgo biloba*. Urbana: Abst. of thesis *Univ. of Illinois*, 1921.

Lee, C. L. 1954. Sex chromosomes in *Ginkgo biloba*. *Amer. Jour. Bot.*, 41:545-549.

Lee, C. L. 1955. Fertilization in *Ginkgo biloba*. *Bot. Gaz.*, 117(2):79-100.

Biol. Abst., 143. 1957.

- Lemaire, C. 1855. *Ginkgo biloba* var. *macrophylla laciniata*. Ill. Hort., 2:27-28.
- Lemesle, R. 1941. De l'existence de complexes tannin-mucilage chez certaines phanerogames (*Ginkgo biloba* L. et quelques especes de *Myristica*) Soc. Bot. de France Bull., 88:424-427.
- Lesley, Mrs. M. C. (Mann). 1924. Microsporogenesis of *Ginkgo biloba* L. with a special reference to the distribution of the plastids and to cell wall formation. Berkeley, California: Univ. of Cal. Agr. Sci. Pub., 2(3):243-248.
- Leung, W., Pecot, R., and Watt, B. 1952. U. S. D. A. Agr. Handbook 34. Composition of Foods Used in Far Eastern Countries. Washington: (U. S. Govt. Print. Off.) 62p. *Ginkgo*: p. 30.
- Ley, W. 1951. Dragons in amber, further adventures of a romantic naturalist. New York Viking, 328p. *Ginkgo*: p. 168-181.
- Li, H. L. 1956. A Horticultural and Botanical History of *Ginkgo*. Morris Arboretum Bull., 7(1):3-11.
- Li, T. T. 1934a. The Development of Embryo of *Ginkgo biloba*. Sci. Rep. Nat. Tsing Hua Univ., Ser. B, 2(1):29-35.
- Li, T. T. 1934b. The development of *Ginkgo* embryo in vitro. Sci. Rep. Nat. Tsing Hua Univ., Ser. B, 2(1):41-52.
- Li, T. T., and Shen, T. 1934c. The effect of "Pantothenic Acid" on the growth of the yeast, and on the growth of the radical of *Ginkgo* embryo in artificial media. Sci. Rep. Nat. Tsing Hua Univ. Ser. B, 2(1):53-60.
- Li, T. T. 1934d. Light and Leaf Development in *Ginkgo biloba*. Sci. Rep. Nat. Tsing Hua Univ., Ser. B, 2(1):11-27.
- Li, T. T., and Chen, S. M. 1934e. Temperature and the development of the *Ginkgo* embryo. Sci. Rep. Nat. Tsing Hua Univ., Ser. B, 2(1):36-40.
- Linne, C. von. 1771. Mantissa plantarum, impensis direct. L. Salvii. D. Holmiae. *Ginkgo*: p. 313.
- Little, E. 1949. Fifty trees from Foreign Lands. (in Trees: Yearbook of Agriculture). U. S. D. A., 944p. *Ginkgo*: p. 20, 48, 53, 78-79, 823-824.
- Loebel, F. 1855a. Sur la multiplication du *Ginkgo b.* (trans. by Duchartre.). Rev. Hort., Ser. 4, 4:331-334.

- Loebel, F. 1855b. Ueber Vermerkung du *Ginkgo b.* (*Salisburia adiantifolia*). *Hamburg Gart. Blumenz.*, 11:62-66.
- Loiseleur-Delongchamps, J. 1834a. Notes historique sur le *Ginkgo biloba* vulgariement noyer du Japon, ou Arbre aux quarante ecus. *Soc. Hort. Paris Ann.*, 15:81-97.
- Loiseleur-Delongchamps, J. 1834b. Recherches sur l'histoire de Cypres et note historiques sur le *Ginkgo biloba*. Paris. *Ginkgo*: p. 20-36.
- Lutz, H. J. 1931. A living Fossil—the Maidenhair Tree. *Amer. Forests*, 37:475-478.
- Lyon, H. L. 1904. The embryogeny of *Gynkgo*. *Minnesota Bot. Stud.*, 3:275-290.
- M. A. 1924. The maidenhair tree. *Mo. Bot. Gard. Bull.*,
- M. A. 1928. Foliar anomalies of *Ginkgo biloba*. 12:64-65 *Gard. Chron.*, 83(2142):28.
- M. A. 1938. The maidenhair tree. *Nature*, 141:280.
- Maekawa, F. 1948. Dichotomy of *Ginkgo* and its bearing to phylogeny (in Japanese, English summ.). *Jap. Jour. Bot.*, 22:119-124.
- Makino, T. 1948. Illustrated Flora of Japan. Tokyo: *Hokuryukan*, 1070p. *Ginkgo*: p. 911.
- Manning, L. 1943. Your shade trees; some unusual varieties. *Amer. Forests*, 49:80-81.
- Manning, W. H. 1927. Exotic Trees for Forest Plantation. *Amer. Forests and Forest Life*, 33 (405):535.
- Manskaya, M. and Koneva, M. N. 1948. Lignins of various plant groups. *Ginkgo biloba*. *Akad. Nauk. U. S. S. R. Doklady*, 62:505-507.
- Martins, C. 1851-4. De la croissance du *Ginkgo biloba* L., sous le climat de Montpellier, comparee a celle de quelques autres Conniferes (1854). *Acad. Sci. Montpellieer Mem. Sect. Sci.*, 2:377-386.
- Martins, C. 1854. Croissance du *Ginkgo biloba* L. a Montpellier comparee a celle de quelques autres Coniferes. *Rev. Hort.*, ser. 4, 3:70-78.
- Masters, M. T. 1869. Vegetable Teratology. London: Pub. for Roy. Soc. by R. Hardwick, 534p. *Salisburia adiantifolia*.
- Masters, M. T. 1902. Conifers. In Forbes and Hemsley, An enumeration of all plants known from China Proper. *Linn. Soc. Bot. Jour.*, 26:540-559.
- Maury, S. W. 1909. The Ginkgo Tree. Louisville, Kentucky: *Nunemaker*, 10p.

- McAtee, W. L. 1911. *U. S. D. A. Biol. Surv. Bull.*, 39. Woodpeckers in relation to trees and Wood Products, 99p. *Ginkgo*: p. 22.
- Medikus, F. C. 1796. Ueber einige auslandische nun wenigstens an den pfalzischen himmelsstrich angewohnnen baume, die wahren nutzen versprechen. In Beeker, W. G., "Taschenbuch fur garten freunde." p. 149-203.
- Medikus, F. C. 1806. In his "Beitrage zur Kultur exotischer Gerwackse." *Ginkgo*: p. 155-164, 189-205.
- Medikus, F. C. 1807. Erfahrungen vom *Ginkgo biloba* (*Salisburia adiantifolia* Sm.). *Forst. Arch.*, 30:211-219.
- Mehra, P. M. 1938. Some abnormalities in the female strobilus of *Ginkgo biloba* L. *Indian Acad. Sci. Proc.*, Ser. B, 8:211-217.
- Mehta, K. R., and Sud, J. D. 1953. Some Ginkgoalean Leaf Impressions from the Rajmahal Hills. *Paleobotanist* (India), 2:51-54.
- Merriam J. C. 1929. Story of a Leaf. *Scribner's M.* 81:130-133.
- Messeri, A. 1930. Lo sviluppo del sistema vascolare e del tessuto di transfusione in plantule di *Ginkgo biloba* L. *Nuovo Giorn. Bot. Ital.*, 37:678-679.
- Messeri, A. 1931. Lo sviluppo del sistema conduttore di *Ginkgo biloba* L. *Nuovo Giorn. Bot. Ital.*, n. s., 38:78-127.
- Messeri, A., and Pecciarini, A. M. 1941. Richerche sulla istologia del legno secondario delle Gymnospermae II. *Ginkgo biloba*. *Nuovo Giorn. Bot. Ital.*, 47(4):675-688.
- Biol. Abst.*, 24177. 1941.
- Metcalf, C. and Flint, W. 1951. Destructive and Useful Insects. N. Y., McGraw-Hill, 1071p. *Ginkgo*: p. 763.
- Metcalf, W. (no year given). Interesting Trees in California. Berkeley: *Univ. California Extension Service. Ginkgo*: p. 10.
- Metzger, F. W., and Grant, D. H. 1932. Repellency to the Japanese Beetle of extracts made from plants immune to attack. *U. S. D. A. Technical Bull.* 299.
- Meyer, F. 1911. Agricultural Exploration in the Fruit and Nut Orchards of China. *U. S. D. A. Bur. Plant Ind. Bull.* 204. *Ginkgo*: p. 51.
- Meyer, K 1938. *Ginkgo* tree. *Deut. Apoth. Zeitung*, 53:1136-1139. *Chem. Abst.*, v. 33, col. 1-4464.
- Meyer, O. 1933. Ein lebendes fossil unter den pflanzen: *Ginkgo biloba*.

Kosmos, 30:312, 315-316.

Milhaus, M. 1924. Le "*Ginkgo biloba*" peut-il servir comme arbre d'alignement? *Jour. Agr. Sud.-Ouest.*, 3:86-87.

Milne, M., and Gerling, J. 1941. Discussions on Fastigate Tree Varieties, Part II. *Trees*, 4(2):13-14.

Miyake, K. 1902. The spermatozoid of *Ginkgo*. *Jour. Appl. Micros.*, 5:1173-1780.

Miyake, K. 1906. Antherozoides of *Cycas revoluta*. *Deut. Bot. Gesell. Ber.*, 24:82-83.

Miyoshi, M. 1931. Merkwürdige *Ginkgo biloba* in Japan. *Deut. Dendrologen Gesell. Mitt.*, 43:21-22.

Möbius, M. 1931. Der *Ginkgo* und die "chichi". (in Japan). *Natur u. Museum*, 61:32-33.

Mölich, H. 1936. Die samenkerne des ginkgo-baumes sind essbar. *Gartenz. (Wien)*. p. 121.

Monoyer, A. 1934. Contribution à l'anatomie du *Ginkgo biloba* L. *Assoc. Franc. pour avanc. des Sci.* Rabat 58 Session. p. 156-157.

Montaigne, L. C. 1836. Notice sur les boutures, et en particulier sur celles du *Ginkgo biloba*. *Soc. Agr. Com. Caen Mem.*, 4:148-151.

Moore, G. G. 1943. Where is the largest ginkgo tree in the U. S.? *Mo. Bot. Gard. Bull.*, 31(5):105-106.

Moore, T. 1862. *Salisburia adiantifolia* fol. *variegatis*. *Hort. Soc. London Proc.*, 2:544.

Morren, C. 1853. Le Ginkgo ou l'Arbre aux quarante ecus. *Belg. Hort.*, 3:293-295.

Moren, E. 1856. Nouvelle variété de l'Arbre aux quarante ecus (éditée par M. Pacob Makoy) *Salisburia adiantifolia* var. *laciniata*. *Belg. Hort.*, 6:148-149.

Morton, J. 1929. Autumn foliage color. *Morton Arboretum Bull. Popular Inf.*, 4(11):34-46.

Mosnat, H. R. 1929. Tree Scion of Ancient Lineage. *Amer. Landscape Architect*, 1(5):25.

Moule, A. C. 1938. Maidenhair Tree, origin of the generic name *Ginkgo* (abstract). *Nature*, 141:280.

Moule, A. C. 1944. The name *Ginkgo*. *Roy. Hort. Soc. Jour.*, 69:166.

- Mulford, F. L. 1922. Trees for Town and City Streets. *U. S. D. A. Farm. Bull.*, 1208, 40p: Ginkgo: p. 4, 18.
- Murakoshi, M. 1952. Illustrated Medicinal Plants. (in Japanese). Tokyo: *Fukumura shosten*, 759p.
- Mussat, E. De l'emploi du *Ginkgo biloba* et de l'utilisation possible de ses fruits. *Rev. Hort.*, 73(9): 206-208.
- Naegeli, C. 1868. Das Wachstum des Stammes. *Beit. zur Wiss. Bot.* Leipzig.
- Nagy, L. von, 1886. *Ginkgo biloba* var. Wien. *Garten-Zeit*, 11:7-10.
- Nathorst, A. G. 1919. *Ginkgo adiantoides* (Unger) Heer in "Tertiar Spitsbergens nebst einer Kunzen nebersicht der ubrigen fossilen Ginkgophyten desselben Landes." *Geol. Foren. Forhandl.* Stockholm, 41:234-248.
- Nayar, S. L. 1954. Poisonous Seeds of India II. *Bombay Nat. Hist. Soc. Jour.*, 52 (2/3):515-532.
- Newcomer, E. H. 1939. Pollen longevity of *Ginkgo*. *Torrey Bot. Club Bull.*, 66:121-123.
- Newcomer, E. H. 1945. Induced parthenocarpy in *Ginkgo*. *Amer. Nat.*, 79:186-187.
- Newcomer, E. H. 1954. The karyotype and possible sex chromosomes of *Ginkgo biloba*. *Amer. Jour. Bot.*, 41(7):542-545.
- Nicholson, G. 1889. *Ginkgo biloba*. *Gard. Chron.*, ser. 3, 26:47-48.
- Nicholas, G. 1924. Sur le dimorphisme sexuel du *Ginkgo biloba* L. et son emploi comme arbre d'alignement. *Feuille Nat.*, 45:68.
- Nobecourt, P. 1952. Studies on the structure and constitution of plant cellular membranes. *Assoc. Tech. Ind. Papetiere Bull.*, 6:1-13. *Chem. Abst.* 6376 i, 1952.
- Nozeran, R. 1949. Les rameaux courts reproducteurs de *Ginkgo biloba*. *Rec. Trav. Inst. Bot. Montpellier Fasc.* 4:68-75
- Nozeran, R. 1955. Contribution a l'etude de quelques structures florales (Essai de morphologie comparee). *Ann Sci. Nat. Bot.*, 16:1-227, Ill.
- Ochi, K. 1956. *Ginkgo* leaves which appear within a year after the seed has germinated. *Amortes Herbarii*. Apr. 1. p. 12.
- O'Hara, K., and Sakae, N. 1941. On difference of tracheid membrane of needle-leaved trees according to directon. *Fibers*, 17:1-13. *Biol. Abst.*, 8663. 1949.

- Oishi, S. 1930. On the cuticles of some fossil Ginkgoacean leaves. *Imp. Acad. Tokyo, Proc.*, 6(3):109-112.
- Oishi, S. 1941. Notes on some Mesozoic Plants from Io-tzu-kuo, Province Chientao, Manchoukuo. *Hokkaido Imp. Univ. Fac. Sci. Jour.*, Ser. 4, *Geol. and Min.*, 6:167-176
Biol. Abst., 6194. 1943.
- Okabe, Y. 1940. Growth-promoting and growth-inhibiting substances in the petiole. (in Japanese, English summ.). *Bot. Mag. (Tokyo)*, 54:357-365.
Hort. Abst., v. 21, no. 63. 1951.
- Okamura, J. 1894. Uber den Gehalt versheidener Holzarten an Holzgummi. *Landw. Versuch.*, 42:437-438.
- Oliver, F. W. 1903. The ovules of the older Gymnosperms. *Ann. Bot.*, 17:451-476.
- Oliver, F. W. 1906. The seed, a chapter in evolution. *British Assoc. Advanc. Sci. Rep. 76th Meet.* p. 725-733.
- Ouden, P. den. 1949. Coniferen, Ephedra en *Ginkgo*. (in Dutch). Wageningen: *Viernman and Louen*, 444p. *Ginkgo*: 368-370.
- Pammel, L. H. 1911. Manual of Poisonous Plants. Cedar Rapids, Iowa: *Torch Press*, 977p. *Ginkgo*: p. 326, 395, 815.
- Pecciarini, A. 1941. Richerche sulla istologia del legno secondario delle *Immun.*, 57:211-227.
- Johnson, R. M., 1957. The agar diffusion technique as applied to the study gymnospermae. *Nuovo Giorn. Bot. Ital.*, 47: 689-692.
- Penhallow, D. P. 1907. Manual of North American Gymnosperms. Boston: *Ginn and Co.*, 374p. *Ginkgo*: p. 14, 28, 51-51, 65, 74, 76, 82, 99, 105, 109, 119, 130, 156, 196, 209., *biloba* p. 110, 209, 358.
- Persons, L. D. 1934. New or Unusual Diseases reported or Observed in Mississippi in Recent years. *Phytopathology*, 24:843.
- Persoon, C. H. 1807. Synopsis plantarum. Paris and Tubingae: A. G. Cottam, 657 p. *Ginkgo*: p. 573.
- Peschier, J. 1818. Recherches analytiques sur le fruit du *Ginkgo*. *Bibl. Univ. de Geneve Sci. Arts*, 7(3):130.
- Pilger, K. 1926. Ginkgoaceae. Die naturlichen pflanzenfamilien. Ed. 2, Leipzig: *Wilhelm Englemann*, 13:98-109.
- Plant Buyers Guide. 1958. edited by H. Gleason Mattoon. Ed. 6, *Boston Hort. Soc.*

- Platt, R. 1947. Our Flowering World. New York: *Dodd Mead*, 278p. *Ginkgos* p. 17, 30, 35, 45, 84-86, 90-96, 98, 107, 110, 111, 113, 114, 119, 121, 125, 141, 184, 224.
- Pollock, E. G. 1957. The sex chromosomes of the Maidenhair Tree. *Jour. Heredity*, 48(6):290-294.
- Popenoe, A. M. Mason, S. C., and Marlatt, F. A. 1890. Descriptive notes on conifers and suggesting planting and pruning methods, *Ginkgo* included. *Kansas Agr. Expt. Sta. Bull.*, 10:13.
- Popular Encyclopedia of Gardening. 1954. London: *Waverly Book Co.*, 3 Vols. *Ginkgo* p. 343.
- Porter, C. L. 1944. A leaf spot disease of *Ginkgo biloba*. *Indiana Acad. Sci. Proc.*, 53:78-80.
Biol. Abst., 20508. 1944.
- Porterfield, W. 1924. Sexual dimorphism and leaf variation in *Ginkgo biloba* L. *China Jour. Sci. and Arts*, 2:255-265.
- Porterfield, W. 1940. Seeds of the *Ginkgo*. *N. Y. Bot. Gard. Jour.*, (4):185-186.
- Prideaux-Brune, H. 1947. The maidenhair tree. *Roy. Hort. Soc. Jour.*, 72:446-450.
- Prideaux-Brune, H. 1948. Some further notes on *Ginkgo biloba*. *Roy Hort. Soc. Jour.*, 73:328-331.
- Py, G. 1932. Recherches cytologiques sur l'assise nouriciere des microspores et les microspores des plantes vasculaires. *Rev. Gen. de Bot.*, 44:316-413, 450-462, 484-512.
- Quisumbing, E. 1925. Stony layer in seeds of Gymnosperms. *Bot. Gaz.*, 79:121-195.
- Radforth, W. 1936. The development in vitro of the proembryo of *Ginkgo*. *Roy. Canadian Inst. Trans.*, 21:87-94.
- Raffineau-Delile, A. 1835. Premiere recolte de fruits du *Ginkgo* du Japon, en France. Montpellier (extrait du Soc. d'Agr. du Dept. de l'Herault Bul. No. De 9bre et 10bre 1835),
- Raffineau-Delile, A. 1849a. Ueber die erste Fruchternte von *Ginkgo b.* im Frankreich im Jahre 1835. *Allg. Gartenblit.*, 17:346-349.
- Raffineau-Delile, A. 1849b. Sur la premiere recolte de fruits du *Ginkgo* du Japon qui ent lieu en France en 1835. *Soc. Agr. Bot. Gard. Ann.*, 5:269-273.
- Rafn, J. 1915. The Testing of Forest Seeds During 25 years. 1887-1912.

Copenhagen, Denmark: *Langkjaers Bogtrykkeri*.

- Read, B. E., and Liu, J. C. 1927. *Plantae Medicinalis Sinensis*, Flora Sinensis. A. I., 106p. *Ginkgo*: p. 59.
- Read, B. E., and Yung, L. W., and Kuang, C. J. 1946. Shanghai Foods. *China Nutritional Aid Council*, 117p. *Ginkgo*: p. 56.
- Record, S. J. 1934. Identification of the Timbers of Temperate North America. New York: *Wiley*, 196p. *Ginkgo*: p. 1, 32, 51.
- Rehder, A. 1927. Manual of Cultivated Trees and Shrubs hardy in North America. New York: *Macmillan*, 496p. *Ginkgo*: p. 1.
- Reisner, J. H. 1921. Nut Culture in China. *Amer. Nut Jour.*, 14:17.
- Rhodes, A. S. 1918. Some new or little known hosts for wood destroying fungi. *Phytopathology*, 8:164-167.
- Rhodes, H. S. 1921. Some new or little known hosts for wood destroying fungi III. *Phytopathology*, 11:324.
- Robertson, A. 1907. The Taxoideae—A Phylogenetic Study. *New Phytol.*, 6(3-4):92-101.
- Robinson, F. 1948. Great *Ginkgo*. *Amer. Forests*, 54:146.
- Royal Horticultural Dictionary of Gardening. 1941. Oxford: *Clarendon*, 2:891.
- Sachs, J. von 1887. Physiology of Plants. Oxford: *Clarendon*, 836p. *Ginkgo*: p. 175, 177.
- Sahni, B. 1915. Foreign pollen in the ovules of *Ginkgo* and of fossil plants. *New Phytol.*, 14:149-151.
- Sahni, B. 1925. Ontogeny of Vascular Plants and the Theory of Recapitulation. *Indian Bot. Soc. Jour.*, 4(6):215.
- Sahni, B. 1933. On some abnormal leaves of *Ginkgo*. *Indian Bot. Soc. Jour.*, 12-13:50-55.
- Saito, J. 1929. Klinische und experimentelle Untersuchung der durch Ginkgo-frucht verursachten Dermatitis und ihrer hautreizenden Bestandteile. *Jap. Jour. Dermatol. and Urol.*, 29(2):105-129. Ger. Summ. 11-13. *Biol. Abst.*, 25080. 1931.
- Saito, J. 1930. Pharmacological study of the *Ginkgo* toxin, component of *Ginkgo biloba* L. which causes dermatitis. *Tokoku Jour. Exptl. Med.*, 16:413-423.
- Sakai, A. 1949. We Japanese. Yokohama, Japan: *Yamagata*, 591p. *Ginkgo*: p. 363, 364.

- Sakisaka, M. 1927. On the morphological significance of seed-bearing leaves of *Ginkgo*. (in Japanese). *Bot. Mag. (Tokyo)*, 41(483):273-278. *Biol. Abst.*, 13393. 1927.
- Sakisaka, M. 1928a. Comparison of the dwarf shoot of *Ginkgo biloba* with the trunk of *Cycas revoluta*. *Jour. Jap. Bot.*, 5(3):101-104.
- Sakisaka, M. 1928b. The real nature of the epiphyllous fruit of *Ginkgo biloba* L. in Mt. Minohu province Kai. (in Japanese). *Jap. Jour. Bot.*, 3:168-170.
- Sakisaka, M. 1929. On the seed-bearing leaves of *Ginkgo*. *Jap. Jour. Bot.*, 4(3):219-235. *Biol. Abst.*, 2364. 1931.
- Sandeman, C. 1947. Gardening in Lima. *Roy. Hort. Soc. Jour.*, 72:30.
- Sax, K., and Sax, H. J. 1933. Chromosome number and morphology in the conifers. *Jour. Arnold Arboretum*, 14:356-375.
- Schaffner, J. H. 1927. *Ginkgo* a flowerless seed plant. *Amer. Jour. Bot.*, 14(3):126-128.
- Schmitz, H. 1921. Concerning the Durability of the Wood of the Maiden-hair Tree, *Ginkgo biloba*. *Jour. Forestry*, 19:165-166.
- Schnarf, K. 1933. Embryologie der Gymnospermen. In *Handbuch der Pflanzenanatomie* 2:2. Berlin.
- Scholz, R. 1932. Microchemical Studies of the Changes During Vernal Activity in *Ginkgo biloba*. *Elisha Mitchell Sci. Soc. Jour.*, 48:133-137.
- Schwerin, F. von. 1922. Über die Schreibweise der "*Ginkgo*." *Deut. Dendrologischen Gesell. Mitt.*, 32:93.
- Scott, D. H. 1904. Structural Botany. Part II. Flowerless Plants. London: A. and C. Black, 341p. *Ginkgo*: p. 304.
- Scott, D. H. 1909. Studies in Fossil Botany, II. Ed. 2, London: A. and C. Black, p. 355-665. *Ginkgo*: p. 392, 458, 517, 529, 538, 539, 542, 544-546, 549, 550, 552, 555, 611, 612, 613, 655. *Ginkgoaceae*: p. 473, 546, 552--544.
- Scott, D. H. 1911. The Evolution of Plants. New York: Henry Holt; London: Williams and Norgate, 256p. *Ginkgo*: p. 57.
- Scott, D. H. 1923. Studies in Fossil Botany, II. Ed. 3, London: A. and C. Black, 433p. *Ginkgo*: p. 275, 282, 299, 301, 304, 308, 311-313, 316, 384, 385, 425.
- Scott, D. H. 1924. Extinct Plants and Problems of Evolution. London:

Macmillan. 240p. *Ginkgo*: p. 103; *biloba* p. 34.

- Seitz, F. W. 1951k, Chromosomenzahlenverhältnisse bei Holzpflanzen. *Zeitchr. Forstgenetish u Forstpflanzensucht*, 1(1):22-32.
- Senft, M. E. 1907. Concerning the substance in *Ginkgo* seeds which develops myelin forms, as well as so-called myelin forms in general. *Pharm. Post.*, 40:265-271, 287-289, 304-307, 319-321. *Chem. Abst.*, 2159(7), vol. 1, 1907.
- Seward, A. C., and Gowan, J. 1900. The maidenhair tree. *Ann. Bot.*, 14:109-153.
- Seward, A. C. 1910. Fossil Plants, II. Cambridge, Eng: *Cambridge Univ. Press*, 624p. *Ginkgo*: p. 307.
- Seward, A. C. 1911. Links with the past in the Plant World. Cambridge, Eng: *Cambridge Univ. Press*, 142p. *Ginkgo*: p. 113, 120-133.
- Seward, A. C. 1917. Fossil Plants, III. Cambridge, Eng: *Cambridge Univ. Press*, 656p. *Ginkgo*: p.7, 61, 62, 119, 135, 139, 173, 222, 251, 266, 294, 301, 306, 327, 333, 338, 339, 398, 499, 502.
- Seward, A. C. 1919. Fossil Plants, IV. Cambridge, Eng: *Cambridge Univ. Press*, 543p. *Ginkgo*: p. 60-62.
(Review, Fossil Plants, IV., Ginkgoales, Coniferales and Gnetales, *London Jour. Bot.* 57:323. 1919, signed E. J. S.)
- Seward, A. C. 1926. The Cretaceous plant-bearing rocks of Western Greenland. *Phil. Trans. Roy. Soc. London (B)*, 215(v.422):57-175.
- Seward, A. C. 1931. Plant Life Through the Ages. New York: *Macmillan*, 601p. *Ginkgo*: p. 71, 72, 139, 149, 225, 226, 262, 362, 385, 440, 441, 459-462, 473, 517, 421, 524.
- Seward, A. C. 1935. Selections from the study of Plant Migrations Revealed by Fossils. *Science Progress*, 32:420-440.
- Seward, A. C. 1937. The Geological History of the Maidenhair Tree and its Allies. *Nature Mag.*, 139:741-745.
- Seward, A. C. 1938. Story of the Maidenhair Tree (Map). *Science Progress*, 32(127):420-440. *Smithsonian Inst. Rept.*, p. 441-460.
- Shaparenko, K. K. 1935. *Ginkgo adiantoides* (Unger) Herr: Contemporary and fossil forms. *Philipp. Jour. Sci.*, 57:1-28. *Biol. Abst.*, 17047. 1937.
- Shaparenko, K. K. 1936. Blizhaishie predki *Ginkgo biloba* L. (Eng. summ.) *Akad. Nauk Bot. Inst. Trudy*, S. S. S. R., Ser. I (*Acta Inst. Bot. Acad.*

- Sci.*, N. R. S. Ser. 1, *Flora et Sept. Plant Vasc.*) 2:5-32.
- Sharp, L. W. 1934. Introduction to Cytology. Ed. 3, New York: McGraw-Hill, 565p. *Ginkgo*: p. 71, 207, 234.
- Shaw, G. R. 1908. A contribution to the anatomy of *Ginkgo biloba*. *New Phytol.*, 7:85-92.
- Shaw, N. 1914. Chinese Forest Trees and Timber Supply. London: Leipsic, 351 p. *Ginkgo*: p. 229.
- Shear, C. L. and Wood, A. K. 1913. Studies of fungus parasites belonging to the genus *Glomerella*. U. S. D. A. Bur. Plant Ind. Bull., 252:33-34.
- Shen, C. I. 1932. Species of *Pestalozzia* and *Monochaetia* in China. *Sci. Soc. China Biol. Lab. Bot. Ser. Contr.*, 7(5):131-141.
- Shimamura, T. 1928. On the formation of the proembryo of *Ginkgo biloba* L. *Bot Mag. Tokyo*, 42(494):71-82.
Biol. Abst., 142. 1930.
- Shimamura, T. 1931. A note on the mitotic division in the proembryo of *Ginkgo*, with special reference to chromatin-elimination. *Bot. Mag. (Tokyo)*, 45(539):525-530.
- Shimamura, T. 1935a. Ueber die Bestäubung und Befruchtung bei *Ginkgo biloba*. *Jap. Jour. Genetics*, 11:180-184.
- Shimamura, T. 1935b. Zur Cytologie des Befruchtungsvorganges bei *Cycas* und *Ginkgo* unter Benutzung der Feulgenschen Nuclealreaktion. *Cytologia (Tokyo)* 6(4):465-473.
Biol. Abst., 12590. 1936.
- Shimamura, T. 1939. On the spermatozoid of *Ginkgo biloba*. *Cytologia (Fujii Jubil. vol. Tokyo)*, p. 416-423.
- Shull, C. A. 1934. A lateral water transfer in leaves of *Ginkgo biloba*. *Plant Physiology*, 9(2):387-389.
- Siebold, P. F. von., et Zuccarini, J. G. 1870. Flora Japon II (edid Moquil), 72-75 T 136.
- Smith, J. E. 1797. Characters of a new genus of plants named *Salisburia*. *Linn. Soc. Trans.*, 330-332.
- Sokolowa, C. 1890. Naissance de l'endosperme dans le sac embryonnaire de quelques Gymnospermes. *Soc. Natural Moscow Bull. 3° Ser.*, 4:446-497.
- Solms-Laubach, H. 1891. Fossil Botany. Oxford: Clarendon, 401p. *Ginkgo*: p. 62, 81, 88, 111, 118, 119, 181.

- Sosa, A. 1947. Sur quelques constituants du *Ginkgo biloba* L. *Soc. de Chim. Biol. Bull.*, 29:833-836.
- Sousa-Bourdouil, C. 1947. Activite diastasiques des inflorescences de *Ginkgo biloba* L. au cours de developpement. *Acad. des Sci. Compt. Rend.*, 224(23):1651-1653.
- Sousa-Bourdouil, C. 1948a. Sur l'absorption de l'eau par les rameaux de *Ginkgo biloba* L. *Paris Mus. d' Hist. Nat. Bull.*, ser. 2, 20(4):427-429 *Biol. Abst.*, 27445. 1949.
- Sousa-Bourdouil, C. 1948b. Sur les acides nucleiques au cours du developpement des inflorescences de *Ginkgo biloba* L. *Acad. des Sci. Compt. Rend.*, 226(11):953-954.
- Sousa-Bourdouil, C. 1949. Etudes physiologiques sur *Ginkgo biloba* L. *Ann. Sci. Nat. Bot. et Biol. Veg.*, 11^e Ser., 10: 145-162.
- Spies, K. V. 1902. *Ginkgo, Cephalotaxus* und die Taxaceen. *Oester. Bot. Zeitschr.*, 52:432-436,469-473.
- Spies, K. V. 1903. *Ginkgo, Cephalotaxus* und die Taxaceen. *Oesterr. Bot. Zeitschr.*, 53:1-9.
- Sprecher, A. 1907. *Ginkgo biloba* L. These, Geneve, Impr. Atar. p. 1-207.
- Standardized Plant Names. 1942. Harrisburg, Pa.: J. Horace McFarland. *Ginkgos* p. 274.
- Starr, A. 1910. Microsporophylls of *Ginkgo*. *Bot. Gaz.*, 49:51-55.
- Stenning, H. W. 1937. *The Gard. Chron.*, 101(2612), 3rd ser. 42.
- Stevens, F. L. 1925. Plant Disease Fungi. New York: Macmillan, 469p. *Ginkgo*: p. 192.
- Steward, F. C. and Caplin, S. M. 1952a. Growth and metabolism of plant cells. III. Evidence for growth inhibitors in certain mature tissues. *Ann. Bot. (London)*, 16:477-489.
- Steward, F. C., and Caplin, S. M. 1952b. Growth and metabolism of plant cells. IV. Evidence on the roles of the cocoanut milk factor in development. *Ann. Bot. (London)*, 16:491-504.
- Stewart, L. B. 1927. Methodis of Propagation. *Roy. Hort. Soc. Jour.*, 27 (1):33-39.
- Stiles, Harvey C. 1903. More about Maidenhair Trees. *Pacific Fruit World*, Los Angeles, Calif. Apr. 25.
- Stone, W. 1938. Letter to the Editor, Reader's Forum. *Amer. Forests*, 44(12):530.

- Stopes, M. C., and Fujii, K. 1906. The nutritive relations of the surrounding tissues to the archegonia of Gymnosperms. *Beit. Bot. Centralblatt*, 20:1-24.
- Stopes, M. C. 1910. Ancient Plants. London: *Blackie*, 198p. *Ginkgo*: p. 7, 8, 14, 66, 69, 70, 98-102.
- Strasburger, E. 1867. Ein Beitrag zur Entwicklungsgeschichte der Spaltöffnungen. *Pringsh. Jahrb. für Wiss. Bot.*, 6:55-103.
- Strasburger, E. 1872. Die Coniferen und die Gnetaceen. Jena: *Gustav Fischer*, 442p. *Ginkgo*: p. 290, 291, 293, 321, 313.
- Strasburger, E. 1879. Die Angiospermen und die Gymnospermen. Jena: *Gustav Fischer*, 173p.
- Strasburger, E. 1882. Ueber den Bau und das Wachstum der Zellhaute. Jena: *Gustav Fischer*, 264p.
- Strasburger, E. 1891. Der Bau der Gymnospermen. Jena: *Gustav Fischer, Hist. Beit.*, 3:45.
- Strasburger, E. 1892. Über das Verhalten des Pollens und die Befruchtungsvorgänge bei den Gymnospermen Schwammsporen, Gameten.
- Strasburger, E. 1879. Die Angiospermen und die Gymnospermen. Jena: *Gustav Fischer, Hist. Beit.*, 4:16, 44.
- Stuart, G. A. 1911. Chinese Materia Medica. Shanghai: *Amer. Presbyterian Mission Press*, 558p. *Ginkgo*: p. 390-391.
- Sturdevant, E. L. 1919. Notes on Edible Plants. Albany: *J. B. Lyon*, 686p. *Ginkgo*: p. 290.
- Sumi, M. 1929. The sterols isolated from several vegetables. *Inst. Phys. and Chem. Res. Tokyo Bull.*, 8:228-233.
- Suzuki, U. 1902a. The Composition of the nuts of *Ginkgo biloba*. *Tokyo Imp. Univ. Col. Agr. Bull.*, 4(5):357-358.
- Suzuki, U. 1902b. On the Occurrence of cane sugar in the seeds of *Ginkgo biloba* and *Camelia theifera*. *Tokyo Imp. Univ. Col. Agr. Bull.*, 4:349-350.
- Sze, H. C. 1933. Beiträge zur Mesozoischen Flora von China. Peking: *Geol. Surv. China*, p. 28.
- Tamaki, W. 1955. Observations on *Ginkgo biloba*. (in Japanese, Eng. summ.) *Jour. Jap. Bot.*, 30(11):340-345.
- Tanaka, N., Takemasa, N., and Sinoto, Y. 1952. Karyotype analysis in

- Gymnospermae. I. Karyotype and chromosome bridge in the young leaf meristem of *Ginkgo biloba* L. *Cytologia*, 17(12):112-123.
- Tang, Y. 1933. Identification of Chinese Softwoods. *Fan. Mem. Inst. Biol. Peiping*, 4(7):321.
- Tang, Y. 1935. Ueber die bindungsweise der essigsäure im ginkgoholz (*Ginkgo biloba*). *Cellulosechemie*, 16:90-92.
- Taylor, W. A. 1941. In *The Standard Cyclopedia of Horticulture*, edit. by L. H. Bailey. New York: *Macmillan*. *Ginkgo*: p. 1338.
- Teng, S. C. 1932a. Fungi of Nanking II by Shen, C. I. *Contr. Biol. Lab. Sci. Soc. China Bot. Ser.*, 8(1):5-48.
- Teng, S. C. 1932b. Fungi of Nanking III, by Shen, C. I. *Contr. Biol. Lab. Sci. Soc. China Bot. Ser.*, 8(2):143-152.
- Teng, S. C. 1932c. Fungi of Nanking IV, by Shen, C. I. *Contr. Biol. Lab. Sci. Soc. China Bot.*, 8(2):153-161.
- Teng, S. C. 1933. Fungi of Nanking V. by Shen C. I. *Contr. Biol. Lab. Sci. Soc. Chin Bot. Ser.*, 8 (3):253-270.
- Tetley, U. 1936. Tissue differentiation in some foliage leaves. *Ann. Bot.*, 50(199):523-557.
- Biol. Abst.*, 19353. 1937.
- Teuscher, H. 1951. The propagation of *Ginkgo biloba* by cuttings. *Parks and Recreation*, 34:10-11.
- Thimann, K. V., and Delisle, A. L. 1939. The vegetative propagation of difficult plants. *Jour. Arnold Arboretum*, 20:116-136.
- Thomas, F. 1865. Zur vergleichenden Anatomie der Coniferen-Laubblätter. *Pringsh. Jahrb. für Wiss. Bot.*, 4:23-63.
- Thommen, E. 1949. Neues zur Schreibung des Namens *Ginkgo*. (Eng. summ.). *Naturf. Gesell. Basel Ver.*, 60:77-103.
- Thomson, R. B. 1905. The megaspore membrane of the Gymnosperms. *Univ. Toronto Stud. Biol.*, Ser. no. 4: 85-146.
- Thorpe's Dictionary of Applied Chemistry, 1941. Ed. 4, New York: *Longmans Green*. *Ginkgo*: p. 536.
- Tieghem, P. van. 1869. Anatomie comparee de la fleur femelle et du fruit des Cycadees, des Coniferes et des Gnetacees. *Ann. des Sci. Nat.*, 5^{me} Ser., 10:269.
- Tieghem, P. van. 1870. Recherches sur la symetrie de structure des plantes vasculaires. *Ann. des Sci. Nat.*, 5^{me} Ser., 13:195.

- Tieghem, P. van. 1887. Sur le second bois primaire de la racine. *Soc. Bot. de France*, 34:101.
- Tieghem, P. van. 1891. *Traite de Botanique*. Paris: *Lib. F. Savy*, 1656p. *Ginkgo*: p. 409, 619, 624, 656, 665, 755, 830, 880, 901, 1320-1332, 1594, 1608.
- Tippo, O. 1942. A Modern Classification of the Plant Kingdom. *Chronica Botanica*, 7:203-206.
- Tobler, F. 1938. Beobachtungen uber den Bau von einigen Bastfasern I and II. *Deut. Bot. Gesell. Ber.*, 56:230-234.
- Tobler, F. 1940. Zur Kenntnis der Blattform von *Ginkgo biloba*. *Deut. Bot. Gesell. Ber.*, 58(6):363-369.
- Biol. Abst., 15313. 1941.
- Tomsone, Z. 1955. Rooting of green cuttings with aid of growth stimulants. *Latvijas: P. S. R. Zinatnu Akad. Vestis*, no. 9 (whole no. 90), p. 107-115. (Russ. summ. p. 115-116).
- Chem. Abst.*, 8394C. 1955.
- Traynard, P., Ayroud, A. M., Emery, A., Robert A., and de Coligny, S. 1954. Distribution of lignin in the secondary wall of vegetable tissues. *Ecole franc papeterie, Genoble Fr. Holzforschung*, 8:42-46.
- Trieber, E. W. 1952. Ultraviolet absorption of cambial saps. *Protoplasma*, 41:452-457.
- Chem. Abst.*, 10450. 1955.
- Trotter, A. 1923. Intorno ad alcuni eccezionali fenomeni d'interesse morfologico e fisiologico in *Aesculus* e *Ginkgo*. *Ann. R. Scuola Sup. d'Agr. Portici* II, 18:22 p.
- Trotter, A. 1938. Foliar anomalies of *Ginkgo biloba*. *Gard. Chron.*, 83:28 (Session of the Fr. Nat. Hort. Soc.)
- Tseng, M. C. 1935. The *Ginkgo biloba* of Chuki District, Chekiang. (in Chinese). *Hortus*, 1:157-165.
- Tubeuf, K. von. 1891. Samen, Fruchte und Keimlinge der in Deutschland hemischen oder eingefuhrten forstlichen Culturpflanzen. Berlin: *Julius Springer*, 154p. *Ginkgo*: p. 34, 96.
- Tukey, H. B. 1944. Plant breeding by incubator methods. *Sci. Monthly*, 58(4):321-322. *Biol. Abst.* 15389. 1944.
- Tulecke, W. 1953. A tissue derived from the pollen of *Ginkgo biloba*. *Science*, 117:599-600.
- Tulecke, W. 1954. Preservation and germination of the pollen of *Ginkgo*

under sterile conditions. *Torrey Bot. Club Bull.*, 81 (6):509-512.

Tulecke, W. 1957. The pollen of *Ginkgo biloba*: in vitro culture and tissue formation. *Amer. Jour. Bot.*, 44(7):602-608.

Tupper, W. W. 1911. Notes on *Ginkgo biloba*. *Bot. Gaz.*, 51:374-377.

Turner, H. E. 1953. Practical blossom (*Ginkgo* fruit) control for the arborist. *Nat. Shade Tree Conf. Proc.* p. 17-20.

Tuzimoto, M. 1940. The occurrence of linolenic acid in the leaves of land plants. *Soc. Chem. Ind. Japan Jour.*, 43 sup. p. 208-209.
Chem. Absts., v. 35, nos. 22-24, 34:79744.

United Nations Food and Agricultural Organ. 1955. Forest and Seed Directory. Rome: F. A. O.

U. S. D. A. Forest Service. 1955. Seed Dealers' List. Washington, D. C.

U. S. D. A. Soil Conservation Tech. Serv. Bull. 27. 1939. Seed Propagation of Trees, Shrubs and Forbs.

Uyeki, H. 1926. Corean timber trees I. Ginkgoales and Coniferales. (in Japanese). *For Exp. Sta. Chosen Rep.* 4. Ginkgo: p. 1-8

Wallace, R. H. 1926. The production of intumescences upon apple twigs by ethylene gas. *Torrey Bot. Club Bull.*, 53(6):385-401.
Biol. Abst., 479. 1928.

Wang, S. 1933. Preliminary notes on the fungus diseases of *Ginkgo* in Han Chow. *Chinese Yearbook Bur Ent. Hangchow* 3:124-138.

Warburg, O. 1913. Die Pflanzenwelt 1:335-338. abb. 85.

Ward, L. W. 1885. The *Ginkgo Tree*. *Science*, 5:495, 497.

Ward, L. W. 1886. Synopsis of the Flora of the Laramie Group. U. S. Geol. Survey 6th Annual Report. p. 405-559.

Webber, H. J. 1897. Notes on the fecundation of *Zamia* and the pollen-tube apparatus of *Ginkgo*. *Bot. Gaz.*, 24:225-234.

Webber, J. J. 1901. Spermatogenesis and fecundation of *Zamia*, U. S. D. A. Bur. Plant Ind. Bull. 2. *Ginkgo*: p. 7-13, 17-23, 26-30, 32, 46-47, 51-52, 54, 56, 58, 60-63, 70, 71, 75, 77-82, 86.

Wehmer, C. 1911. Die Pflanzenstoffe. Jena: Gustav Fischer. *Ginkgo*: p. 2.

Wehmer, C. 1929. Die Pflanzenstoffe. Jena: Gustav Fischer 1:1.

Wehmer, C. 1931. Die Pflanzenstoffe. Jena: Gustav Fischer 2:1290.

Weiss, A. 1865. Untersuchgen uber die Zahlen-und Grossenverhaltnisse der

- Spaltöffnungen. *Pringsh. Jahrb. fur Wiss. Bot.*, 4:125-196.
- Wester, H. V., and Marth, P. C 1954 3-C1-IPC found effective for removal of *Ginkgo* fruits. *Arborists News*, 19(10):83.
- Wettstein, R. 1899. Die weibliche Blute von *Ginkgo*. *Uesterr. Bot. Zeitschr.*, 49:417-425. T. 7.
- Wettstein, R. 1935. Handbuch der systematischen Botanik Deutliche. Leipzig and Wien: *F. Deutiche*, 1152p. *Ginkgo*: p. 292, 294 450, 510, 596.
- Widder, F. von. 1948. Die Rechtschreibung des Namens "*Ginkgo*." *Phyton*, 1:47-52.
- Widder, F. von. 1949. *Ginkgo* and Telomtheorie. *Natur. Ver. f. Steiermark Mitt.*, 77/78:181-183.
- Wieland, G. R. 1899. A study of Some American Fossil Cycads, Pt. III. *Amer. Jour. Sci.*, 7:383.
- Wieland, G. R. 1906. American Fossil Cycads. *Carnegie Inst. of Wash.*, vol. 2, 267p. *Ginkgo*: p. 124, 216, 239.
- Wieland, G. R. 1935. *Ginkgo*. *Science*, 81:515-516.
- Wigglesworth, G. 1903. The Cotyledons of *Ginkgo biloba* and *Cycas revoluta*. *Ann. Bot.*, 17:789-791.
- Williams, R. S. 1924. Fruiting of the Maidenhair Fern Tree. *Jour. N. Y. Bot. Gard.*, 25:271-272.
- Williams, R. S. 1926. *Ginkgo biloba*; Maidenhair Tree. *Addisonia*, 11(2): 19-20.
- Wilson, E. H. 1913a. Aristocrats of the Trees (Patriarchal *Ginkgo*). Boston: *Stratford*, 279p. *Ginkgo*: p. 14, 17, 41-57.
- Wilson, E. H. 1913b. A naturalist in Western China II. London: *Methuen*, 229p. *Ginkgo*: p. 13, 30.
- Wilson, E. H. 1916. The conifers and taxads of Japan. *Arnold Arboretum Publ.* no. 8.
- Wilson, E. H. 1919. The romance of our trees. II. The *Ginkgo*. *Gard. Mag.*, 30(4):144-148.
- Winton, A. L., and Winton, K. B. 1932. Structure and Composition of Foods. Seeds of the *Ginkgo* family, New York. *John Wiley*, 1:46-48.
- Wise, L. 1944. Wood Chemistry. New York: Reinhold, 900p. *Ginkgo* p. 281.

- Worsdell, W. C. 1897. On the origin of "Transfusion Tissue" in the leaves of Gymnospermous Plants. *Linn. Soc. Trans.*, (2):301.
- Wright, J. G. 1928. The pit-closing membrane in the wood of the lower gymnosperms. *Roy. Hort. Soc. Canada Trans.*, 22(1):63-94.
Biol. Abst., 3132. 1929.
- Wyman, D. 1951, Trees for American Gardens, New York: *Macmillan*, 376p. Ginkgo: p. 1, 4.
- Yamabayashi, N. 1928. Identification of Korean woods. (in Japanese). *For Exp. Sta. Chosen*, no. 7, 56p.
- Yamamoto, T. 1935. On the Biology of *Dictyoploca japonica*. (in Japanese). *Oyo-Dobuto Zasshi* (Tokyo), 7(4):200-203.
- Yamashita, T., and Sato, T. 1930. Shikiminic acid from the leaves of *Ginkgo biloba* L. *Pharm. Soc. Jap. Jour.*, 50:113-117.
- Zerova, M. I. 1940. Some *Phomopsis* species new for U. S. S. R. *Jour. Bot. U. S. S. R.*, 1(2):305-312.
- Ziegenspeck, H. 1829. Die Nadeln der erwachsenen und keimenden Koniferen und die Phylogenie dieser Klasse, eine phylogenetische-anatomische Studie. *Bot. Arch Leipzig*, 26(3/4):257-348.
- Zimmerman, M. S. 1896. Die Morphologie und Physiology des pflanzlichen Zellkern. Jena: *Gustav Fischer*, 188p. Ginkgo: p. 66, 105, 107, 109.
- Zimmerman, W. 1930. Die Phylogenie der Pflanzen. Jena: *Gustav Fischer*, 452p. Ginkgo: p. 22, 276, 277-282.
- Zuccarini, J. G. 1840. Beitrage zur Morphologie der Coniferen. *Bay. akad.*

A PRELIMINARY REPORT ON AN OCCURRENCE OF CAMPOSTOMA ANOMALUM (RAFINESQUE) IN THE YADKIN RIVER DRAINAGE SYSTEM

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A new record of *Campostoma anomalum* (Rafinesque) from the Yadkin River drainage system was taken in a collection (RDR No. 802) made by R. D. Doss, Kenneth Cook, and Jerry Wakeman, July 16, 1957, from Johnson Creek, 3.5 miles SE of Fancy Gap in Carroll County, Virginia. This appears to be a race of the New (Upper Kanawha) River campostomid tentatively described as *kanawhanum* Ross, 1952, and published as a *nomen nudum* (Ross, 1958). It also shows some relationship to the Roanoke and James River campostomids published as *virginianum* (Ross, 1958, *nomen nudum*) and tentatively described as *roanokense* (Davis, 1953). It shows some parallelism with the Santee River sub-race of *C. A. anomalum* described by Ross in 1952. The Yadkin, Roanoke, and James River forms, however, are probably best regarded as races of the undescribed New River form.

The Yadkin and New River forms show a relationship in six characters, (1) number of scales in the lateral line, (2) number of scales around caudal peduncle, (3) number of scales from lateral line to lateral line across the back anterior to the dorsal fin, (4) number of scales anterior to the dorsal fin, (5) number of scales below lateral line from origin of anal fin plus number of scales below lateral line from base of pelvic fin, and (6) number of scales below lateral line to anal plus number below lateral line to pelvic, plus number of scales around caudal peduncle. (Tables I, II and IV). In two characters, number of lateral line scales and number of caudal peduncle scales, this relationship is very close. The Yadkin and Roanoke River races approach each other in these characters and in the characters: (1) number of scales from lateral line to lateral line across anterior to the pelvic fins, and (2) number of scales in lateral line plus number of scales around body. The Yadkin specimens show no significant relationship with the other forms in number of scales around body minus the number of scales around the caudal peduncle (Table I), and it is believed that the correspondence which appears between the Yadkin and Santee forms in the number of scales around body plus number of lateral line scales (Table III) is due to parallel evolution.

This record provides biological evidence for Wright's (1931) suspected stream capture from the New River drainage in the Hillsville area, and

lends credence to Evermann's (1916) record of *Campostoma anomalum* from the Lumbee (Lumber) River of Yadkin drainage in North Carolina. It is hoped that further collections will provide more specimens for study and that a more complete report on the Yadkin campostomids can be made at a later date.

ACKNOWLEDGEMENT

The author is most grateful to Dr. R. D. Ross for making available his collection of the Yadkin campostomids for study, for permitting use of his data concerning the New and Santee River forms and for his advice and guidance concerning this study. Also, I wish to thank Mr. W. S. Davis for giving his permission to use data from his unpublished thesis.

TABLES I-IV. SCALE NUMBERS IN *Campostoma anomalum* FROM DIFFERENT COLLECTING SITES

TABLE I

Forms From:	Number	Range	Mean	σ	σM
Lateral Line Scales					
Yadkin River	23	47-56	50.9	2.4	0.50
New River	350	43-58	50.6	2.4	0.13
Roanoke River	53	45-55	49.4	1.8	0.25
Santee River	68	46-57	50.1	2.1	0.26
Scales Around Body					
Yadkin River	23	35-42	39.6	1.79	0.37
New River	334	40-56	48.1	3.2	0.17
Roanoke River	53	39-52	45.1	3.6	0.29
Santee River	68	33-51	40.8	2.7	0.33
Scales Below Lateral Line to Anal Fin Plus Scales Below Lateral Line to Pelvic Fin Plus Caudal Peduncle Scales					
Yadkin River	23	32-40	36.4	1.76	0.37
New River	141	30-48	39.6	3.5	0.30
Roanoke River	44	32-39	35.0	3.0	0.44
Santee	68	31-37	34.2	1.3	0.15

TABLE II

Forms From:	Number	Range	Mean	σ	σM
Lateral Line to Lateral Line Across Back					
Yadkin River	23	16-19	17.2	0.88	0.18
New River	256	16-23	19.1	1.2	0.08
Roanoke River	53	16-23	18.3	1.3	0.18
Santee River	68	15-18	16.3	0.90	0.11
Scales Around Caudal Peduncle					
Yadkin River	23	20-24	21.5	1.3	0.27
New River	192	18-23	22.3	1.6	0.12
Roanoke River	53	16-23	19.9	1.2	0.16
Santee River	69	19-23	20.4	0.8	0.10
Scales Around Body Minus Scales Around Caudal Peduncle					
Yadkin River	23	14-21	17.96	1.7	0.35
New River	136	17-34	25.6	3.2	0.28
Roanoke River	53	19-31	25.2	3.3	0.45
Santee River	68	14-26	20.1	2.5	0.30

TABLE III

Forms From	Number	Range	Mean	σ	σM
Scales Around Body Plus Lateral Line Scales					
Yadkin River	23	85-98	90.5	3.6	0.74
New River	343	86-111	98.8	4.5	0.24
Roanoke River	53	85-113	94.5	4.6	0.63
Santee River	68	83-99	90.5	3.2	0.39

TABLE IV

Forms From:	Number	Range	Mean	σ	σM
Scales from Lateral Line to Lateral Line across Belly					
Yadkin River	23	20-25	22.3	1.3	0.27
New River	253	19-35	26.9	2.7	0.17
Roanoke River	53	20-33	25.1	2.4	0.33
Santee River	70	19-27	22.2	1.9	0.23
Scales Anterior to the Dorsal Fin					
Yadkin River	23	20-27	23.4	1.6	0.32
New River	148	22-29	25.2	1.6	0.13
Roanoke River	44	21-28	24.3	1.5	0.22
Santee River	69	19-26	21.5	1.3	0.15
Scales Below Lateral Line From Anal Fin Plus Below Lateral Line From Pelvic Fin					
Yadkin River	23	13-16	14.5	0.78	0.16
New River	207	12-21	15.8	1.5	0.11
Roanoke River	44	11-24	15.2	2.1	0.32
Santee River	69	12-17	13.9	1.1	0.13

LITERATURE CITED

- Davis, W. S. 1953. *Campostoma anomalum roanokense*, a new subspecies of the stoneroller minnow in the James and Roanoke Rivers. M.S. Thesis, Virginia Polytechnic Institute, Blacksburg, Va. (typewritten).
- Evermann, B. W. 1916. Notes on the fishes of the Lumbee River. *Copeia*, 36:77-80.
- Ross, Robert D. 1952. The subspecies and races of the cyprinid fish *Campostoma anomalum* (Rafinesque) in eastern United States. Ph.D. thesis, Cornell University, (typewritten).
- 1958. Some taxonomic problems of Shenandoah River fishes. Tech. Bull. 137, pp. 1-10, p. 7. Va. Agric. Expt. Sta., V. P. I., Blacksburg, Va.
- Wright, F. J. 1931. The Older Appalachians of the South. *Jour Sci. Lab.* (Denison University, Granville, Ohio), 26:143-250.

THE TUBE PRECIPITATION TECHNIQUE AS APPLIED TO THE STUDY OF SEROLOGICAL RELATIONSHIPS AMONG CRAYFISHES¹

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Much of our knowledge of serological systematics has been gained from the work of Dr. A. A. Boyden and his students at Rutgers University. An excellent review and critique of the methods and goals of comparative serology has recently been published (Boyden, 1958). Using the tube precipitation method with the hemocyanins of the Crustacea as antigens, it has been found that the serum proteins of members of a given genus are serologically more similar to one another than they are to members of other related genera (Leone, 1949). The hemocyanins of some of the crayfishes have been investigated by Leone and Pryor (1952); five species of crayfishes of the family Astacidae and five species of the Australian crayfishes of the family Parastacidae were compared. Results showed that species within the genus *Orconectes* (family Astacidae) are closely related. Within the family Parastacidae, the genera *Cherax* and *Euastacus* differ serologically but are more closely related to one another than to species of the family Astacidae.

The present study was undertaken in order to shed more light on the taxonomic relationships among members of the genus *Cambarus* (family Astacidae). Since it is difficult to distinguish intrageneric difference serologically, members of the genera *Orconectes*, *Procambarus*, and *Pacifastacus*, family Astacidae) were included in order to determine the specificity of the antisera prepared.

MATERIALS AND METHODS.—The Crayfishes belonging to the genus *Cambarus* which were used in this study have been assigned to three groups; *Cambarus bartonii bartonii* (Fabricius), *C.b.sciotensis* Rhodes, *C. b. robustus* Girard. and *C.b.subsp.* of the Bartonii group; *C. montanus acuminatus* Faxon of the Montanus group; and *C.longulus longulus* Girard, *C.l.longirostris* Faxon, and *Cambarus* species of the Longulus group.²

Four species of the genus *Orconectes*. [*O.juvenilis* (Hagen), *O.nais* (Faxon), *O.immunis* (Hagen) and *O.propinquus* (Girard)], two species of the genus *Procambarus* [*P.clarkii* (Girard) and *P.blandingii acutus*

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²Personal communications from Dr. Horton H. Hobbs, University of Virginia who also identified the crayfish.

(Girard)], and one species of the genus *Pacifastacus* [*P.trowbridgii* (Stimson)] were included.³

The crayfish sera were collected and the antisera prepared in the same manner as reported by Johnson (1957).

The Libby photorefractometer was used to record the turbidities in a series of tube precipitations. The sensitivity of this instrument has been established by Boyden, Bolton and Gemeroy (1947), and Bolton, Leone and Boyden (1948).

The procedure utilized in these tests was essentially the same as that of Leone (1949). The volume of antiserum was constant while the volume of antigen (crayfish serum) was varied (alpha precipitation).

Data for serological comparisons were obtained by a summation of the turbidity units, a value proportional to the area under the curve. Such a summation of the turbidities produced by an antiserum and its specific antigen (homologous curve) is the standard of comparison between that antiserum and any heterologous antigen. This summation is arbitrarily assigned a value of 100 percent (Boyden, 1954.)

The tests combining the various antigens and antisera were run three times unless otherwise noted in Table I and the standard deviation from the mean computed.

RESULTS.—Table I shows the results of interaction of the crayfish antigens with the antisera prepared. The numbers represent the percent correspondence of the various antigens tested with the anti-serum indicated. These figures are the mean percent of three series of tests (except for those with an asterisk).

It can be seen that the members of the genus *Cambarus* are closely related and, because of the standard deviation of some of the tests, cannot be considered significantly different. With all of the antisera prepared against the members of this genus, significant differences between them and members of the genera *Orconectes*, *Procambarus*, and *Pacifastacus* were demonstrated. A notable exception was the antiserum prepared against *Cambarus* sp. and the unexplainable reaction between the antiserum prepared against *C.b.robustus* and the antigen of *P.trowbridgii*.

The results of the tests utilizing the antiserum prepared against the serum of *O.juvenilis* may be interpreted as indicating that the members of the genus *Orconectes* available for this study are more closely related to the members of the genus *Cambarus* than to those members of the genera *Procambarus* and *Pacifastacus* listed in Table I.

³Sera from *O.nais*, *O.immunis*, and *P.trowbridgii* were kindly supplied by Dr. Charles A. Leone, University of Kansas, Lawrence, Kansas.

TABLE I. SEROLOGICAL COMPARISON AMONG CRAYFISHES¹

ANTIGENS	<i>C.b.bartonii</i>	<i>C.b.robustus</i>	<i>C.b.sciotensis</i>	<i>C.m. acuminatus</i> (a)	<i>C.m. acuminatus</i> (b)	<i>C.l.longulus</i>	<i>Cambarus</i> sp.	<i>O.juvenilis</i>
<i>Cambarus</i>								
<i>C.b.bartonii</i>	100	93	82	95	92	85	86	73
<i>C.b.robustus</i>	88	100	83	84	94	95	81	74
<i>C.b.sciotensis</i>	93	98	100	82	97	93	90	90
<i>C.b.subsp.</i>	85	95	81	87*	97		83	85
<i>C.m.acuminatus</i>	78	97	82	100	100	86	84	68
<i>C.l.longulus</i>	84	90	84	66*	91	100	100	81
<i>C.l.longirostris</i>	86	92			93	87		78
<i>Cambarus</i> sp.	85	90	75	75	95	87	100	79
<i>Orconectes</i>								
<i>O.juvenilis</i>	57	79	68*	54*	65		85*	100
<i>O.immunis</i>	57*	76	69*	49*			89	
<i>O.nais</i>	44	77			59			82
<i>O.p.propinquus</i>	57	78			63			98
<i>Procambarus</i>								
<i>P.b.acutus</i>	51*	65			53			63
<i>P.clarkii</i>	47*	64			45			60
<i>Pacifastacus</i>								
<i>P.trowbridgii</i>	60*	89			62			65

¹The numbers represent the mean percent of the homologous test (100). An asterisk indicates that the test was run only once. The standard deviation for these mean percent values may be obtained by writing to the author.

CONCLUSION.— The members of the genus *Cambarus* utilized in this study are very closely related serologically and, due to unsatisfactory specificity of the antisera prepared, cannot be significantly distinguished by this technique. Johnson (1957) states that *C.m.acuminatus* (Montanus group) appears to be serologically identical to the members of the Bartonii group using the agar diffusion method of Elek. Results of the present tests would tend to substantiate this conclusion as the antiserum (a), prepared against *C.m.acuminatus* in column four of Table I indicates a slightly closer affinity with the members of the Bartonii group than with those of the Longulus group. It may be of interest that antiserum (a) was used in the agar diffusion tests, whereas, antiserum (b) prepared against the

same subspecies was developed after the agar diffusion studies were completed.

It is doubtful whether the members of the Longulus group can be separated from the members of the Bartonii and Montanus groups with the data from the antisera used. Perhaps by absorption of the antisera, using the antigens of other closely related Crustacea, greater serological differences could be demonstrated among members of the genus *Cambarus*. Until this can be done, the present taxonomic affinities of this group, based on morphology, biogeography and ecology, cannot be disputed.

Significant serological differences are demonstrated between these members of the genus *Cambarus* and members of the other genera compared (*Orconectes*, *Procambarus*, and *Pacifastacus*) substantiating the usefulness of this technique in making intergeneric serological comparisons.

SUMMARY

The Libby Photronreflectometer was used in measuring the turbidities in a series of tube precipitation tests.

Antisera were prepared against the sera of six members of the genus *Cambarus*, and one member of the genus *Orconectes*. Each antiserum was tested with its homologous antigen and various heterologous antigens (Table I).

Significant serological differences were noted between the members of the genus *Cambarus* and those members of the genera *Orconectes*, *Procambarus*, and *Pacifastacus* utilized but could not be demonstrated within the three groups of the genus *Cambarus*.

LITERATURE CITED

- Bolton, Ellis T., C. A. Leone, and A. A. Boyden, 1948. A critical analysis of the performance of the photronreflectometer in the measurement of serological and other turbid systems. *Jour. Immun.*, 58:169-181.
- Boyden, A. A., 1954. The measurement and significance of serological correspondence among proteins. Serological approaches to studies of protein structure and metabolism. Ed. by William Cole. *Rutgers University Press*, New Brunswick, New Jersey, 74-97.
- Boyden, A. A., 1958. Comparative Serology: aims, methods and results. Serological and biochemical comparisons of proteins. Ed. by William Cole. *Rutgers University Press*, New Brunswick, New Jersey, 3-24.
- Boyden, A. A., E. T. Bolton, and D. Gerneroy, 1947. Precipitin testing with special reference to the photoelectric measurement of turbidities. *Jour. Immun.*, 57:211-227.
- Johnson, R. M., 1957. The agar diffusion technique as applied to the study

of serological relationships among crayfishes. *Va. Jour. Sci.*, 3:177-184.

Leone, C. A., 1949. Comparative serology of some brachyuran Crustacea and studies of hemocyanin correspondence. *Biol. Bull.*, 97(3):273-286. Crustacea. *Biol. Bull.*, 103 (3):433-445.

Leone, C. A., Carlon W. Pryor, 1952. Serological comparisons of Astacuran Crustacea. *Biol. Bull.*, 103(3):433-445.

THE IN VITRO EFFECTS OF X-RADIATION ON HUMAN WHITE BLOOD CELLS

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One of the most constant alterations which occurs in animals exposed to moderate doses of ionizing radiation is the marked decline in circulating leucocytes. This decline may be attributed to radiation damage of the hemopoietic system rather than direct effects on circulating cells (Cronkite and Brecher, 1955). Nonetheless, changes in motility and phagocytic activity of circulating cells have been indicated *in vivo* following whole body x-irradiation (Fishman and Shechmeister, 1955, Shechmeister and Fishman, 1955).

The question then arises of the sensitivity of the various leucocyte types to *in vitro* ionizing irradiation. Lymphocytes have been shown to be quite sensitive to *in vitro* x-radiation (Schrek, 1946a, Patt et. al. 1952). Results of studies with granulocytes, however, vary from no effect following 600 r (Hiramatsu and Okamoto, 1948) and enzyme alteration following 50,000 r (Wagner, et.al. 1957). In the present study, use is made of recent advances in leucocyte isolation (Skoog and Beck, 1956) to investigate the sensitivity of leucocyte type, the neutrophil, to x-radiation. Attempts were made to modify the radiation effects using glutathione, ethylenediamine-tetraacetic acid, and reduced temperature.

METHODS.—Venous blood from healthy human volunteer donors was heparinized (0.4 mg per ml) and mixed with dextran² (one percent final concentration for thirty minutes) to speed red cell sedimentation. The leucocytes were harvested from the plasma by centrifugation at one hundred times *g* for fifteen minutes. The cells were washed twice in modified Hank's solution (McKinney et.al. 1953) and finally centrifuged in protein sedimentation tubes at eight to ten times *g* for thirty minutes or in fifteen ml centrifuge tubes at about 300 times *g* for ten seconds. Both methods resulted in actively motile cells and satisfactory red to white cell ratios (ranging from ten to 0.1 but usually near one). Cells were suspended finally in modified Hank's solution.

All glassware was cleaned with alcoholic potassium hydroxide,

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thoroughly rinsed, dried, and coated with G. E. Dri-Film. The coating was removed and replaced after each experiment. Hypodermic needles were coated with G. E. Dri-Bake.

X-irradiation was carried out in glass test tubes at room temperature. A total dose of 80,820 r was delivered at a dose rate of 449 r per minute over a period of three hours using the inherent filtration of the machine (three mm aluminum) plus one mm aluminum. The cells were resuspended every thirty minutes. Total doses of 6,450 r, 12,900 r and 25,800 r were delivered at a dose rate of 215 r per minute using 0.25 mm copper and three mm aluminum added filtration. The x-radiation was delivered by a 250 Kvp, fifteen ma machine. Dose rates were determined with a Victoreen thimble chamber calibrated by the National Bureau of Standards.

Reduced glutathione (GSH) and ethylenediaminetetraacetate (EDTA) as the disodium salt were prepared in Hank's solution to give final concentrations of 10^{-3} M and 10^{-4} M, respectively. The pH was adjusted to 7.4 with sodium hydroxide.

Following irradiation cells were incubated at 37°C and shaken 80 times per minute to keep them in suspension. Samples were removed to microscopic slides at intervals following irradiation and scored under oil immersion phase microscopy for the number of motile neutrophils per 100 neutrophils counted. In all instances, non-irradiated samples were run under the same conditions as the irradiated samples. Where possible, the tubes containing the cells were randomized so that the observer could not tell which sample was being counted.

RESULTS.—The first observable morphological alteration following x-irradiation was partial sphering of the neutrophil with a continuation of a pseudopodia formation. Upon contact with the slide, cells in this condition spread out and continued to form pseudopodia although not always in a definite direction. Nuclei and cytoplasmic viscosity as indicated by Brownian movement appeared normal. The next morphological change appeared in cells taken at a longer interval following irradiation. These cells remained spherical and exhibited no pseudopod formation. Such cells would stick to the surface of the slide but, in general, tended not to spread out. The nuclei still appeared normal, but the cytoplasmic viscosity was increased as indicated by decreased Brownian movement. None of these effects was apparent immediately after irradiation but were noted in 50 per cent of the cells four hours after the highest x-ray dose. The same series of changes were observed in non-irradiated preparations aged ten to fourteen hours.

The neutrophils displayed remarkable resistance to x-radiation as may be seen in figure 1a where motility is plotted as a function of dose. With an x-radiation dose of 80,820 r, the mean percent motility of neutrophils in Hank's solution was reduced only 53 percent of the controls at four hours after the radiation. The dose-effect curve was exponential at the lower doses

but tended to flatten out at the highest dose (fig. 1a).

An attempt was made to modify the effects of x-radiation on neutrophil motility by the addition prior to irradiation of glutathione or EDTA, both of which are agents shown to offer protection against ionizing radiations (Barron et. al, 1949. Bacq and Alexander, 1955). Samples of cells with Hank's solution alone, with Hank's solution plus glutathione, and with Hank's solution plus EDTA were given 80,820 r, a dose which caused appreciable effects on cell motility (see fig. 1a). The results are shown in table 1. Although the variation was large because of the long irradiation time necessary to accumulate 80,820 r (three hours), the radiation protection by glutathione was evident. EDTA proved to be toxic to the cells

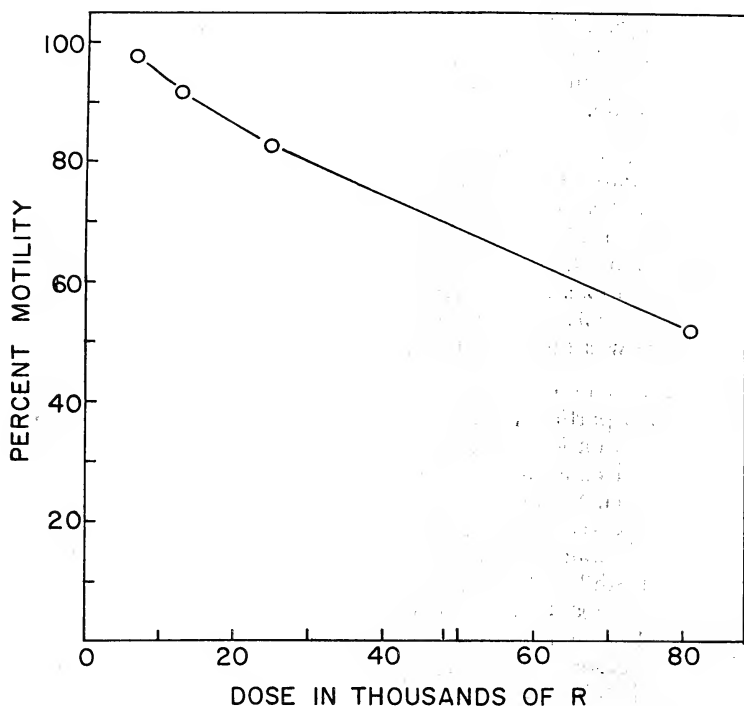


Fig. 1a. Dose effect curve for neutrophil motility. The percent motility was determined four hours after the end of the x-irradiation. The percent motility was determined as $\frac{n}{n_0} \times 100$ where n was the number of motile neutrophils from the irradiated sample and n_0 was the number of motile neutrophils from the non-irradiated sample.

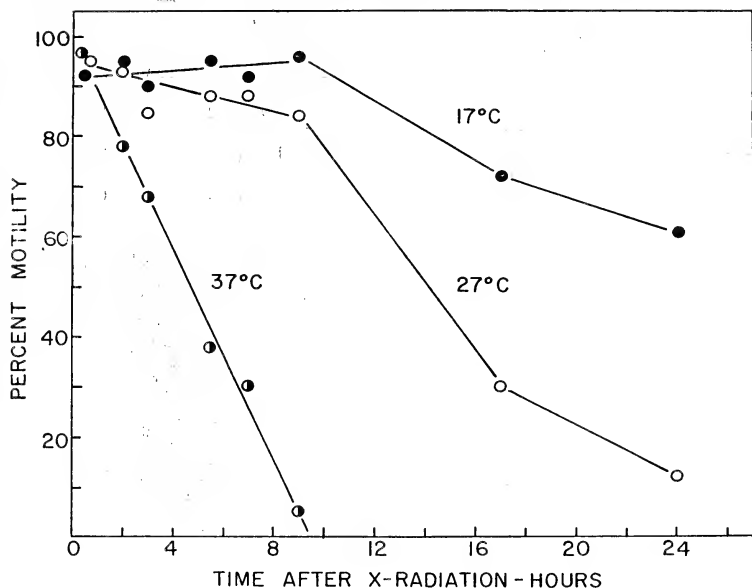


Fig. 1b. Effect of temperature on x-radiation induced inhibition of neutrophil motility. Dose, 80,820 r. Percent motility was determined as in 1a.

such that the motility of the non-irradiated cells with EDTA was significantly lower than the motility of the non irradiated cells in Hank's solution alone after four hours incubation. However, there was no increase in damage to cell motility attributable to x-irradiation.

Protection by post-irradiation incubation at lowered temperatures is firmly established for x-irradiation (Schrek, 1946b, Stapleton et. al. 1953). Reduced incubation temperatures were found to decrease the effect of x-irradiation on neutrophil motility as indicated by the persistence of motility for a longer time in the irradiated cells (fig. 1b).

DISCUSSION.—Neutrophils, despite their susceptibility to other types of injury (Martin et. al. 1955), exhibited a marked resistance to x-irradiation, the dose required for neutrophil immobilization being about 80 times that required for lethality of lymphocytes (Schrek, 1946a). A consideration of the two factors which would contribute to this resistance. First is the inability, or at most limited ability, of leucocytes to synthesize deoxyribonucleic acid (Winzler, 1957, Kline and Clifton, 1952), an activity shown to be sensitive to x-radiation in other cells. Bacq and Alexander, 1955). A second factor is suggested from the demonstration that glutathione protected neutrophils from x-radiation. Since reduced sulfhydryl groups, in

Treatment	No x-radiation	80,820r x-radiation	P
Control	63 \pm 17 (5)	40 \pm 20 (6)	0.001
10 ⁻³ M GSH	55 \pm 17 (5)	53 \pm 19 (6)	0.3
10 ⁻⁴ M EDTA	35 \pm 24 (6)	35 \pm 13 (6)	0.8

TABLE 1.—Effect of GSH and EDTA on x-radiation induced inhibition of neutrophil motility. Data are expressed as motile neutrophils per 100 neutrophils counted, with standard deviations. Number of experiments given in parentheses. The X_2 method was used to test the difference between the motility of non-irradiated and irradiated samples. P indicates the probability that this difference could occur by chance alone. P values smaller than 0.01 are regarded as statistically significant.

general, afford protection against ionizing radiations (Barron et. al. 1949, Patt et. al. 1952), the normally high content of reduced sulfhydryl groups in leucocytes (Green and Martin, 1955, Hardin et. al. 1954) would be consistant with decreased radiation sensitivity.

The similarity between the morphological changes which appeared shortly after x-radiation and those which appeared in non-irradiated cells aged about twelve hours would suggest that immobilization and eventual cell death in both cases were attributable to the same, or similar, mechanisms. Certain observations made here offer some basis for speculation about this similarity as well as the sites or radiation damage. First, the protection of neutrophils by lowered temperatures and by reduced glutathione implicates the metabolism of the cell in radiation induced immobilization (see Barron et. al. 1949, Stapleton et. al. 1953). Support for this comes from the demonstration of a decreased enzyme activity in leucocytes as manifest by reduced oxygen consumption following 50,000 r (Wagner et. al. 1957). The contribution of enzyme alteration to cell immobilization cannot be evaluated, however, without more study directed specifically toward this interrelation. Second, the morphological change from a flattened amoeboid cell to a sphere, i.e., increased volume with a reduction in surface-volume ratio, most probably results from an alteration in cell permeability prior to immobilization. Precedent for this type of alteration may be found in the work of Sheppard and Stewart (1952) where x-radiation induced permeability changes in erythrocytes were demonstrated. It has also been shown that leucocyte permeability, at least to potassium, increases with aging particularly when the cells are shaken as in the present experiments (Hempling 1952).

A point which must be kept in mind is the possibility that cell immobilization is a terminal event, the causes of which are varied. In view

of this, it may not be profitable to seek one site of radiation damage in neutrophils. Rather it is more likely that enzyme damage and membrane alteration are but two of several factors which contribute to x-radiation induced immobilization in these cells.

SUMMARY

1. Suspensions of human neutrophils in Hank's solution were found to be quiet resistant to x-irradiation using cell motility as a criterion of effect. Morphological changes noted in the neutrophils following radiation were similar to changes noted in aged cell preparations.
2. Glutathione offered some protection against the effects of x-radiation.
3. Reduced incubation temperatures following x-irradiation offered striking protection against the radiation effects.
4. The results are consistent with radiation damage to enzyme systems and to the cell membrane prior to immobilization.

LITERATURE CITED

- Bacq, Z. M. and P. Alexander. 1955. Fundamentals of Radio-biology. *Academic Press*, New York.
- Barron, E. S. G., S. Dickmen, J. A. Muntz and T. P. Singer. 1949. Studies on the mechanism of action of ionizing radiations. I. Inhibition of enzymes by x-rays. *J. Gen. Physiol.* 32:537-552.
- Cronkite, E. P. and G. Brecher. 1955. The protective effect of granulocytes in radiation injury. *Ann. N. Y. Acad. Sci.* 59: 815-883.
- Fishman, M., and I. L. Shechmeister. 1955. The effect of ionizing radiation on phagocytosis and the bactericidal power of the blood. II. The effect of radiation on ingestion and digestion of bacteria. *J. Expt. Med.* 101: 275-290.
- Green, R., and S. P. Martin. 1955. The nonprotein, soluble sulfhydryl content of human leukocytes and erythrocytes in infection and leukemia. *J. Lab. Clin. Med.* 45:119-122.
- Hardin, B., W. Valentine, J. H. Follette, and J. S. Lawrence. 1954. Studies on the sulfhydryl content of human leukocytes and erythrocytes. *Am. J. Med. Sci.* 228: 73-82.
- Hempling, H. G. 1952. Potassium loss in rabbit leucocytes in response to mechanical agitation. *J. Cell. Comp. Physiol.* 40:161-164.
- Hiramatsu, H. and S. Okamoto. 1948. The effect of Roetgen irradiation

upon the function of leucocytes *7th Ann. Meet. of Japan, Med-Radiol. Assoc. Tokyo*: 1-17.

Kline, D. L. and E. E. Clifton. 1952. The life span of leucocytes in the human. *Science* 115:9-11.

Martin, S. P., G. R. McKinney, and R. Green. 1955. The metabolism of human polymorphonuclear leukocytes. *Ann. N. Y. Acad. Sci.* 59:996-1002.

McKinney, G. R., S. P. Martin, Jr., R. W. Rundles, and R. Green. 1953. Respiratory and glycolytic activities of human leukocytes *in vitro*. *J. Applied Physiol.* 5: 335-340.

Osgood, E. E. and G. J. Bracher. 1939. Culture of human marrow; studies of the effects of Roetgen-rays. *Ann. Intern. Med.* 13:563-575.

Patt, H. M., M. E. Blackford, and R. L. Straube. 1952. Effect of x-rays on thymocytes and its modification by cysteine. *Proc. Soc. Exp. Biol. Med.* 80:92-97.

Schrek, R. 1946a. Studies *in vitro* on cellular physiology. The effect of x-ray on the survival of cells. *Radiology.* 46: 395-410.

Schrek, R. 1946b. Studies *in vitro* on the physiology of cells. Factors affecting the delayed cytotoxic action of x-rays. *J. Cell. Comp. Physiol.* 28:227-304.

Shechmeister, I. L. and M. Fishman. 1955. The effect of ionizing radiation on phagocytosis and the bactericidal power of the blood. I. The effect of radiation on migration of leucocytes. *J. Expt. Med.* 101:259-274.

Sheppard, C. W. and M. Stewart. 1952. The direct effects of radiation on erythrocytes. *J. Cell. Comp. Physiol.* 39 (suppl. 2): 189-215.

Skoog, W. A. and W. S. Beck. 1956. Studies on the fibrinogen, dextran and phytohemagglutinin methods of isolating leukocytes. *Blood* 11:436-454,

Stapleton, G. E., D. Billen, and A. Hollaender, 1953. Recovery of x-irradiated bacteria at suboptimal incubation temperatures. *J. Cell. Comp. Physiol.* 41:345-357.

Wagner, R., N. Meyerriecks, and C. Z. Berman. 1957. *In vitro* effects of x-radiation on white blood cells and blood platelets. *Blood* 12:733-745.

Winzler, R. J. 1957. Anticancer agents and nucleic acid metabolism of isolated human leukocytes. In ed. Rebeck, J. W., F. H. Bethell and R. W. Monton. *The Leukemias. Academic Press. New York.* 567-581.

News And Notes

(Editor's Note). *News contributions should be sent to the person whose name appears at the end of the appropriate sections.)*

MINUTES OF THE COUNCIL MEETING

Newcomb Hall, Charlottesville

March 8, 1959

The meeting was held in Newcomb Hall at the University of Virginia. Dr. Forbes, Academy President, called the meeting to order at 10:45 a.m. He had invited the Section Chairmen or their designate to attend this meeting. Those present were:

J. C. Forbes; William G. Guy; William M. Hinton; Horton H. Hobbs, Jr.; Harry G. M. Jopson; George W. Jeffers; William Scott; Robert T. Brumfield; Robert H. Brownson; James W. Cole; Paul M. Patterson; William G. Lowry; Jacques Rappaport; S. P. Maroney, Jr.; Sidney S. Negus; Thelma C. Heatwole; J. C. Holmes; S. S. Obenshain; John T. Hack; Foley F. Smith; and William B. Wartman, Jr.

It was moved and passed that the reading of the minutes of the October 1958 meeting be omitted since they were printed in the Journal.

OLD BUSINESS

Treasurer's Report: The Treasurer's report included the proposed budget and a statement of the estimated income for 1959. The estimated income is about \$400.00 in excess of the proposed expenditures and the balance in the General Fund on January 1, 1959 was \$5,433.60. It was moved and passed that the Treasurer's report be accepted.

The Treasurer read a portion of the minutes of the Finance and Endowment Committee pertaining to the raising of \$1500.00 additional income. It was pointed out that since the estimated income for 1959 exceeds the proposed budget, there was no urgent need for recommending means of raising additional income. Finance Committee members were urged, through personal contacts, to assist the Business Membership Committee in increasing the Business Members in the Academy.

The Finance Committee recommended that Council request the Trustees to invest \$3,000.00 of the approximately \$5,000.00 balance in the General Fund. This is to be invested in some short-term earning capacity. This was approved by Council.

Funds for Study of Results of Science Talent Search: Mr. Joseph Holmes, Chairman of the Science Talent Search Committee, reported that requests for funds from the National Science Foundation, the Ford Foundation and the Old Dominion Foundation had not met with any success. He suggested

that since this is a local state project, that it may be best to seek funds within the state. Dr. Jeffers suggested that Dr. Lowry of the University of Virginia be consulted as the possibility of this study being undertaken by a graduate student in the School of Education.

Institute for Prospective College Seniors and Their College Teachers: Dr. Forbes briefly reviewed this proposal. A grant has been requested from the National Science Foundation to support this program.

Proposed Program for the Improvement of Science Teaching in the Colleges of Virginia: A joint application by the Virginia Academy of Science and the University Center in Virginia for funds to support this program has been submitted to the National Science Foundation. This proposal was discussed briefly by Dr. Forbes.

Status of the Dismal Swamp Project: Dr. Forbes reported that Dr. Baldwin was unable to attend the meeting. Dr. Baldwin will write the History Section and he feels that the Geology Section needs some revision. Dr. Hack reported that nothing new on the geology of the Dismal Swamp has been written for some time. This will be discussed in the Geology Section at the May meeting.

NEW BUSINESS

Report of the Virginia Journal of Sciences Dr. Brumfield reported that Dr. Lane was unable to be present, and that this was an interim report. A new printing contract at the present rate has been arranged with the present printer, whose bid was low. Economies previously discussed have been effected, and this has resulted in reducing the annual Journal deficit occurring in recent years. This deficit is due to increase in printing and other expenses, without increase in revenue. The Journal is still operating at an annual loss of about \$1000.00 The present balance is about \$3,000.00. Dr. Brumfield requested that invitational papers be submitted.

Report of Local Committee on Arrangements: Dr. Maroney reported that the program had been submitted to the Virginia Journal of Science for publication in the April issue. Contracts for thirteen commercial exhibits have already been made.

Dr. Rappaport reported on the housing arrangements. He recommended that members make housing reservations as early as possible. The gymnasium will have accommodations for about 100 students.

Programs for Junior Academy Members: Mrs. Heatwole proposed that the Junior Academy be allowed to charge a 25c Registration Fee to cover the cost of programs for the May meeting. It was felt that this would encourage Junior members to attend section meetings. It was moved and passed that the Junior Academy be allowed to charge 25c Registration Fee to cover the cost of a program, this fee to be turned over to the Treasurer of the Senior

Academy. It was suggested that 200 additional programs be printed for this purpose.

Report of Science Talent Search Committee: J. C. Holmes, Chairman, reported that there were eight students from Virginia who received "Honorable Mention" in the National Talent Search, which is the best record in recent years.

The Committee is concerned since there are many sections in the state which rarely or never participate in the Science Talent Search. As one possible approach to encouraging statewide participation in this program, they suggested that 100 high school science teachers, who are outstanding graduates of Virginia colleges, be written and urged to encourage students to pursue scientific careers and participate in Science Day meetings: The Committee requested Council to consider this and other possible means of increasing the participation in the Science Talent Search especially in those sections of the state which are not now active in the program.

Dr. Forbes requested Council members to consider this matter, and it is hoped that additional recommendations be brought up at the May meeting.

Goethe Award: Each year the Academy is the grateful recipient of a liberal contribution by Dr. C. M. Goethe, who has requested that the Academy advise him as to how this contribution can best be used. It was decided that \$50.00 of this contribution be designated the Goethe Award and that it be awarded each year to married graduate students, preferably with at least two children, to help defray their expenses to the annual Academy meeting in May. Dr. Goethe is to be advised of this action.

Dr. W. W. Scott of the Virginia Polytechnic Institute will select the two recipients of the Goethe Award for the 1959 Academy meeting.

Mrs. Heatwole reported that the Junior Academy is considering the establishment of a traveling library and asked if this action would have to be approved by Council. She was advised that Council approval was necessary.

Dr. Forbes thanked the section Chairmen for attending and participating in the discussions. With regret, he reported that Dr. Ralph Bradley had accepted a faculty position at the University of Florida and was therefore resigning from the Council. A member to replace Dr. Bradley will be elected at the May meeting.

The meeting was adjourned at 7:15 p.m.

— P. M. Patterson

AGRICULTURAL SCIENCE

Dr. Leonard W. Feddema has been appointed Associate Professor of Horticulture at the Virginia Polytechnic Institute effective July 1, 1959.

Dr. Feddema will serve as Extension Vegetable Specialist in the position formerly held by L. C. Beamer, who retired on March 31, 1959.

The National Institutes of Health has awarded a research grant for the study of the inheritance of resistance to insecticides in the German cockroach to Dr. D. G. Cochran, Associate Professor of Entomology, and Dr. J. M. Grayson, Professor of Entomology in the amount of \$6,633 for the first year and for a total of \$16,256 for a three-year period.

The National Institutes of Health has awarded a research grant for the study of insects as vectors of infectious synovitis in poultry to Dr. E. M. Raffensperger, Associate Professor of Entomology, and Dr. J. W. Davis, Professor of Animal Pathology in the amount of \$8,286 for the first year and a total of \$29,124 for a four-year period.

Mr. Monte E. Juillerat has been appointed Assistant Professor of the Virginia Polytechnic Institute. He is a native of Columbia City, Indiana with his M. S. from Purdue University and completed requirements for his Ph. D. at Purdue University. He will work initially in the area of livestock marketing research in the Department of Agricultural Economics.

The Nutrition Foundation, Inc., New York, New York, has announced renewal of its grant in the amount of \$12,000 for the next three years to Dr. Russell Miller and Dr. R. W. Engel, Department of Biochemistry and Nutrition of the Virginia Polytechnic Institute. This grant continues support of studies of the biochemical and physiological role of dietary molybdenum, sulfate, and copper in animals. Of special interest is the influence of molybdenum feeding on selected enzyme systems and upon certain physiological abnormalities. Molybdenum toxicity conditions are found in many areas of the world in grazing animals consuming grasses naturally high in molybdenum.

The National Institutes of Health have awarded Dr. C. J. Ackerman, Department of Biochemistry and Nutrition of the Virginia Polytechnic Institute, \$12,755 for the next three years to continue present studies upon the biochemical, chemical and physiological effects of ethylene oxide fumigation and treatment of proteins and amino acids. To be emphasized will be studies to determine the effect of ethylene oxide upon selected enzyme systems. Ethylene oxide has been used commercially as a cold sterilization agent for some food stuffs.

Dr. Russell Miller, Associate Professor, Department of Biochemistry and Nutrition, talked to the Virginia Military Institute student affiliates of the American Chemical Society on Wednesday, April 22. The talk developed the history of biochemistry and emphasized the many and varied research problems currently being worked upon by staff and graduate students at the Virginia Polytechnic Institute.

The Virginia Polytechnic Institute contributed in unprecedented force

to the annual meetings of the Federation of American Societies for Experimental Biology in Atlantic City in April which brought together over 10,000 scientists from all over the world. Three research reports and one symposium paper were presented by members of the staff of the Departments of Biochemistry and Nutrition and of Biology. Drs. C. J. Ackerman (Bio. N.), W. A. Hardison (Dairy Science), and K. W. King ('49, Biol.) were elected to membership in the American Institute of Nutrition. A group of nineteen Tech alumni and staff got together for a Virginia Polytechnic Institute dinner, including Dr. J. W. Gill (Ph.D., V.P.I., 1957, now at the University of New Hampshire, Durham, New Hampshire), Dr. J. H. Hash (Ph.D., V.P.I., 1956, now with Bowman-Gray Medical School, Winston-Salem, North Carolina), Lt. Brendan E. Joyce (M.S., V.P.I., 1955, from Army Medical Training School, Fort Sam Houston, Texas), and Dr. H. G. Windmueller (Ph.D., V.P.I., 1958, now at Brandeis University, Boston, Massachusetts).

James F. Eheart ('19), Associate Biochemist, Virginia Agricultural Experiment Station, was elected Chairman of the Southern Pesticide Residue Cooperative Research Group at a recent meeting in Fayetteville, Arkansas. This group consists of workers from eight Southern states, Puerto Rico, and the United States Department of Agriculture.

Dr. Grant Thomas, Assistant Professor of Agronomy at the Virginia Polytechnic Institute attended a four week course at Oak Ridge on the use of tracer techniques as a research tool.

Professor J. A. Schad, State president of the newly organized Industrial Arts Association in Virginia, represented the Virginia Polytechnic Institute and the State at the annual convention of the American Industrial Arts Association in Long Beach, California, April 22-25. Professor Schad is head of Industrial Arts Education in the department of Vocational Education, Virginia Polytechnic Institute.

Dr. Harry Huffman, Head of Business Education, was awarded a plaque by the Roanoke Chapter of the National Office Management Association "in recognition of achievement in training for business". This is the first time that such recognition was made by the Roanoke Chapter of NOMA. Dr. Huffman was also a recent teacher and consultant at several out of state meetings including Phoenix, Arizona and Long Beach, California. On the same trip he also visited business education departments and participated in discussion groups at San Diego, Los Angeles, San Francisco, San Jose, and Sacramento, California.

Recently off the press is *The Clerical Program in Business Education*. This publication is the sixteenth American Business Education yearbook. Dr. Harry Huffman and Professor Jeffery R. Stewart, Jr., both of the Business Education staff, the Virginia Polytechnic Institute, are editor and associate editor respectively. The 470 page volume contains material that

will be used by Business educators for many years to come.

The staff of the Department of Agricultural Education of Ohio State University were guests of Dr. T. J. Horne and his staff in Agricultural Education at the Virginia Polytechnic Institute on May 11 and 12. The visitors made an intensive study of the plans, program, organization, and accomplishments of the local department and observed the work of several departments of vocational agriculture in the Southwest Virginia area.

ASTRONOMY, MATHEMATICS, AND PHYSICS

Dr. T. M. Hahn, Jr., Head of the Department of Physics at the Virginia Polytechnic Institute, has accepted the position of Dean of the College of Arts and Sciences at Kansas State University. No successor has yet been appointed.

The new Physics building at the Virginia Polytechnic Institute is now under construction, with the installation of the 10 KW reactor scheduled for the fall. The building will be in use by January 1960.

Dr. Bruno Alter, comes to Randolph-Macon Woman's College as acting chairman of the Physics Department this fall. He holds the Ph. D. degree from Lehigh and is presently on the faculty of Vanderbilt University.

The University of Virginia will offer an NSF Institute for high school teachers again this summer. Dr. F. L. Brown of the University of Virginia and Dr. T. E. Gilmer of Hampden-Sydney will teach the physics group.

Several colleges within the state took advantage of the Visiting Scientist Program of the AIP during this past year. Among them were the Virginia Military Institute, the University of Richmond and the Virginia Polytechnic Institute.

W. W. Walker will join the staff at the college of William and Mary as assistant Professor of Physics this fall. Dr. Walker recently received his Ph.D. at the University of Virginia.

In the fall of this year, the college of William and Mary will reactivate the Master's program in Physics.

Dr. Stephan Berko returns in September to the University of Virginia. He has been working at the University of Copenhagen as a Sloan Fellow.

Dr. S. W. Mitchell, well known solid state physicist of Great Britain, will become a permanent member of the physics faculty at the University of Virginia, this fall. Dr. Mitchell, a native New Zealander, is a Fellow of the Royal Society and has been honored for his work in many ways.

Richard E. Grove, professor of Physics at Randolph-Macon College, will receive his Ph.D from Syracuse this June.

Dr. E. T. S. Walton, Nobel prizewinner in 1951, gave a series of

lectures at Randolph-Macon this spring. This was his first stop in a tour of the United States.

Dr. Harold Alden, University of Virginia astronomer, will attend the Second Astrometric Conference May 17-20. This Conference, supported by the NSF, is devoted to the creation of more interest in the determination of fundamental star positions.

—I. G. Foster,
Virginia Military Institute

BACTERIOLOGY

The award established by the Virginia Branch of the Society of American Bacteriologists for an outstanding contribution to the Science Fair was presented at the annual meeting of the Virginia Academy of Science: First Prize (\$25.00 and a certificate)—William Ridenour, winning the reward for a second time, (sponsored by Mrs. R. B. Painter) of the William Fleming High School, Roanoke, for "Comparison of Chemical and Radiological Mutation in *E. coli*"; Second Prize (Honorable Mention)—Barbara Sink (sponsored by Mr. C. W. Holhurt) of Boiling Springs High School, Covington, for "Incidence of *Candida albicans* in the Saliva of White Rats."

Dr. Quentin N. Myrvik presented a paper entitled "Serum and tissue lysozyme levels in rabbits undergoing a granulomatous reaction induced by BCG" at the International Symposium on Fleming's Lysozyme held the 3rd to 5th of April at Milan, Italy.

—P. Arne Hansen,
University of Maryland

BIOLOGY

Mr. T. H. Ma has completed his graduate work at the Blandy Experimental Farm and the University of Virginia, majoring in plant genetics, and has accepted a position in the Biology Department of Emory and Henry College. His new work started in June, 1959.

Dr. A. B. Massey, Professor of Botany, Virginia Polytechnic Institute, will retire at the end of the 1958-59 academic session. He will continue his work on the Flora of Virginia as Emeritus Professor of Botany and Curator of the Herbarium.

Dr. Jane Belcher of Sweet Briar College will be on sabbatical leave during 1959-60. Miss Belcher will visit Nigeria where she expects to do some work with certain amphibians. Miss Rose Mary Johnson, a candidate for the Ph.D. degree at the University of Virginia, will replace Miss Belcher during the latter's leave.

Dr. J. L. McHugh, Director of Virginia Fisheries Laboratory since 1951, has resigned to accept an appointment as Chief of the Division of

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Biological Research, Bureau of Fisheries, U. S. Fish and Wildlife Service. Dr. William J. Hargis has been appointed Acting Director of the Laboratory.

A. Randolph Shields, a candidate for the Ph.D. degree in botany at the University of Tennessee, has been appointed Assistant Professor of Biology at Roanoke College, effective September 1, 1959.

Dr. B. F. D. Runk, Professor of Biology at the University of Virginia, has been appointed Dean of the University, effective March 1, 1959.

President Colgate W. Darden, Jr. of the University of Virginia, recently announced that an anonymous donor has given over \$500,000 to strengthen biology teaching and research at that institution. Simultaneously he announced that the National Institutes of Health will grant \$612,000 for research facilities in the planned Life Science Building for which the General Assembly has appropriated two million dollars. Plans for the building are now well advanced and it is hoped that ground can be broken for the construction, late in 1959.

—Walter S. Flory, Jr.,
University of Virginia

CHEMISTRY

Miss Virginia Celeste Ellett, a chemistry teacher at Thomas Jefferson High School, Richmond, Virginia, was selected by the Virginia Section of the American Chemical Society to receive its Distinguished Service Award for the year 1959 for her outstanding contributions to science teaching and to the building of interest in secondary school science in Virginia. Miss Ellett was awarded the Hitchcock Prize and a scroll of merit at a dinner party given in her honor on June 5. Miss Ellett, a native Virginian, received her B. S. degree from Westhampton College and her M. Ed. degree from the University of Virginia. In 1951, she received a General Electric Fellowship in Chemistry and physics for work at Union College, Schenectady, New York. Miss Ellett has been an outstanding leader in secondary school science activities in the State. She has arranged a General Science Course which is being used by many teachers as a course of study. She has developed an Advanced Chemistry Course for high school students, which is being used as a model in other states. Because of Miss Ellett's efforts, many industrial organizations, including the du Pont Company, the Reynolds Metals Company, The American Tobacco Company, the Virginia Institute for Scientific Research, Philip Morris, Inc., and Experiment, Inc., are providing material assistance and even instructors to teach the students who are capable of doing college-level work in chemistry. Miss Ellett was awarded a Science Fellowship recently for teachers of advanced chemistry courses to attend the 1959 Summer Institute sponsored by the National Science Foundation at Bowdoin College. In June, she will participate in a

conference in Denver for teachers of Advanced Placement courses. She and some of her students recently attended the first Atomic Use Conference in Atlantic City, New Jersey. This Distinguished Service Award of the Virginia Section of the American Chemical Society is made possible annually by Mrs. Henry K. McConnell in memory of her husband, who for many years was a great leader in industrial chemistry in the South.

In recognition of his outstanding contributions to the advancement of science in the South, Mr. Edward Swain Harlow, Assistant Managing Director of Research, Department of Research and Development of the American Tobacco Company was selected to receive the 1959 Distinguished Service Award of the Virginia Section of the American Chemical Society. The award, a scroll of merit, was presented to Mr. Harlow at a dinner party given in his honor on June 5, Mr. Harlow native Virginian, graduated from John Marshall High School and received his B. S. degree from the University of Richmond. He served as an instructor in physics for two years while at the University. Mr. Harlow was previously employed by the Western Electric Company and by the Division of Chemistry of the Virginia Department of Agriculture. He was granted a leave of absence from The American Tobacco Company to serve in the U. S. Navy and during his tour of duty was awarded both the Navy commendation ribbon and the Bronze Star Medal. Mr. Harlow's Investigations in the fields of the composition of tobacco and tobacco smoke have resulted in the publication of numerous scientific papers. In addition to his responsibility for the expanding research program of The American Tobacco Company, Mr. Harlow's activities include membership on the Operating Committee of Industrial Reactor Laboratories, Inc., at Plainsboro, New Jersey. Full scale operation of the recently completed swimming pool type reactor is now anxiously awaited by the ten participating companies. He was closely associated with the construction and operation of the Radiological Nutriculture Laboratory, which was completed and presented to the Medical College of Virginia by The American Tobacco Company in May, 1956. For several years, he has served as research associate in the Department of Pharmacology at the Medical College of Virginia and aids in the coordination of research on the pharmacological and physiological aspects of tobacco and tobacco smoke carried on under a research grant by The American Tobacco Company to the college. In addition, he assists in the administration of other fundamental research sponsored by the company at several institutions of higher learning and research institutes.

Dr. J. Samuel Gillespie, Jr., formerly an associate of Edwin Cox, Chemist and Chemical Engineer, Aylett, Virginia, has been made a partner in the new firm of Cox and Gillespie, Chemists and Chemical Engineers. The firm has opened a consulting office offering chemical and engineering services at 5 North Sixth Street, Richmond, Virginia, in addition to its Aylett facilities. Dr. Gillespie is a graduate of the Virginia Military Institute

and the University of Virginia. He was previously associated with the Virginia-Carolina Chemical Corporation and was Assistant Professor of Chemistry at the University of Richmond.

—Mearl A. Kise,
Virginia Smelting Company

ENGINEERING

Mr. Tilton E. Shelburne, Director of the Virginia Council of Highway Investigation and Research, attended a meeting of the Board of Directors of the American Society of Civil Engineers in Cleveland, Ohio in May. In April Mr. Shelburne attended the Advisory Committee meeting on the AASHO road test at LaSalle, Illinois and in May he was a member of the Performance Rating Panel on this road test. At the University of Virginia Mr. Shelburne was active in organizing the Soils Mechanics Conference which was held in March. Professor William Zuk of the Civil Engineering Department of the University attended the meeting of the Society of Experimental Stress Analysis in May.

Dean Lawrence R. Quarles of the Engineering School attended the Southwestern Regional meeting of the American Society for Engineering Education at Tuscaloosa, Alabama in April. As representative of Governor Almond he attended a meeting in Nashville, Tennessee in April of the Regional Advisory Council on Nuclear Energy. Professor Orville R. Harris of the Electrical Engineering Department of the University of Virginia Section of the Institute of Radio Engineers. He attended the annual meeting of the IRE in New York in March.

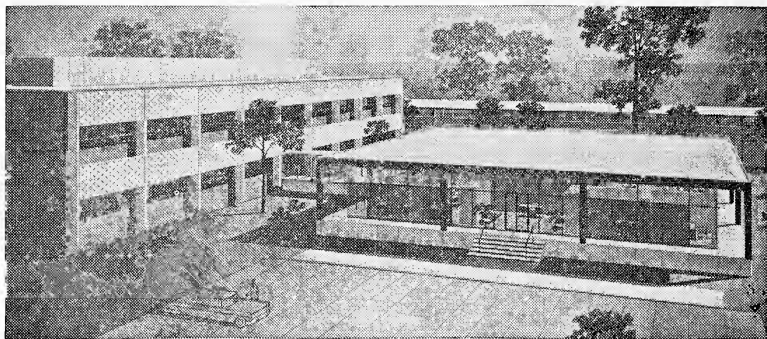
Professor Otis L. Updike of the Chemical Engineering Department of the University of Virginia was co-chairman for local arrangements of the Eastern Stimulation Council which held a meeting in Charlottesville in April. During the summer of 1959 Professor Updike will fill a research participation appointment in the Chemical Technology Division of the Oak Ridge National Laboratory in Oak Ridge, Tennessee.

Professor Robert W. Truitt of the Aeronautical Engineering Department of Virginia Polytechnic Institute has recently written a textbook "Hypersonic Aerodynamics" published by the Ronald Press Company. Professor A. C. Bruce, on leave of absence from the Aeronautical Engineering Department at Virginia Polytechnic Institute, has completed a year of graduate work toward the Ph.D. degree in Aeronautical Engineering at Massachusetts Institute of Technology.

—R. M. Hubbard,
University of Virginia

PSYCHOLOGY

John F. Hahn of the Psychology Laboratory, University of Virginia,



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was elected President of the Psychology Section, Virginia Academy of Science, at the May 8 meeting. Other new officers were Robert A. Johnston, of the University of Richmond, Secretary-Treasurer, and Richard H. Henne-man of the University of Virginia, Executive Committeeman.

Cletus Cole of Arlington, Virginia, assumed office as President for the current year for the Virginia Psychological Association. New officers elected at the meeting on May 9 were President Elect, Frank Finger of the University of Virginia, and Treasurer, William Dunn, Jr., of V. A. Hospital, Richmond.

Notes from the Annual Meeting: Our thanks and appreciation go to Ken Lloyd for making the program arrangements and seeing that the meeting ran smoothly. The banquet was a tremendous success thanks to Art Bachrach's effort ably abetted by ample liquid refreshments. The symposium on Training of Psychologists almost floundered in a welter of amiability in spite of Frank Finger's egging everyone on until Dick Henneman stepped into the breach, took potshots here and there, so that the conflict between experimental and clinical psychology can be expected to burn brightly for another year. A nice little extra-curricular argument flared briefly at Tom Lahey's over the question of sterilization. This might be a program topic for some time in the future since individuals appear to be available who could participate with feeling.

Robbert Gibbey and Max Hutt have produced a new book "The Child: Development and Adjustment". The event occurred around the beginning of May; midwife was Allyn and Bacon, of Boston.

Hannah S. Davis of Lynchburg Training School and Hospital and Fred Lipschitz of Southside Area Guidance Clinic, Petersburg, both having successfully defended their dissertations in oral examination will receive their doctorates in June. Miss Davis will receive her degree from Columbia University, Teachers College; her thesis is entitled "Judgment of Intellectual Level from Various Features of the Rorschach, Including Vocabulary." Mr. Lipschitz will receive his degree from Adelphi University; his thesis is entitled "An Investigation of The Self Concept Systems and Reactions to Frustration of a Group of Process and Reactive Schizophrenics."

Florence Farley, Central State Hospital, Petersburg, announces a program of summer work experience for undergraduates interested in going into graduate preparation in psychology or other mental health professions. Four positions have been established to permit students to rotate through various hospitals of the Department in order to become acquainted with the functions of these departments in the diagnosis and treatment of mental illness, to observe and work with patients suffering from various sorts of mental illness, and to leave the experience with a positive attitude toward mental illness and a desire to enter one of the professions in this field.

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SIXTH AT BYRD STREET

Richmond, Virginia

McGuire V. A. Hospital in Richmond hopes to establish a similar program.

E. Ray Harcom of William and Mary has received a \$15,000 grant from NIMH which he will share with H. R. Blackwell of Ohio State Research Foundation to study certain factors possibly underlying reading disability. This study will last two years.

—Penelope Lewis,
Western State Hospital

STATISTICS

Effective September 1, 1959, R. A. Bradley will leave the Department of Statistics at the Virginia Polytechnic Institute to become chairman of the new Department of Statistics being formed at the Florida State University, Tallahassee, Florida. He has also been named representative on the Division of Mathematics of the National Research Council of the Eastern North American Region of the Biometric Society.

Boyd Harshbarger attended the Third Exploratory Conference on Missile Model Design for Reliability Prediction at the White Sands Proving Ground in April. He also attended the undergraduate training program at the Medical College of Virginia.

The American Statistical Association index for volumes 35-50 which has been a two-year project under the auspices of the Virginia Polytechnic Institute Department of Statistics has been submitted to the American Statistical Association. The editors of this volume are Charles Clunies-Ross, William A. Glenn, and Leroy S. Brenna.

Clyde Y. Kramer of the Department of Statistics was one of the instructors giving a short course on design of experiments at Perdue University from June 9-19.

Five of the students studying under the National Institutes of Health Training Grant at the Department of Statistics are spending the summer at the Medical College of Virginia.

John Bartko and James Kent began their graduate programs in statistics at the Virginia Polytechnic Institute in March 1959.

—Clyde Y. Kramer,
Virginia Polytechnic Institute

THE ANNUAL SUBSCRIPTION RATE is \$3.00, and the cost of a single number, \$1.00. Reprints are available only if ordered when galley proof is returned. All orders except those involving exchanges should be addressed to Charles F. Lane, Stevens Hall, Longwood College, Farmville, Virginia. The University of Virginia Library has exclusive exchange arrangements, and communications relative to exchange should be addressed to The Librarian, Alderman Library, University of Virginia, Charlottesville, Virginia.

NOTICE TO CONTRIBUTORS

Contributions to the Journal should be addressed to Robert T. Brumfield, Stevens Hall, Longwood College, Farmville, Virginia. If any preliminary notes have been published on the subject which is submitted to the editors, a statement to that effect must accompany the manuscript.

Manuscripts must be submitted in triplicate, typewritten in double spacing on standard 8½" x 11" paper, with at least a one inch margin on all sides. Manuscripts are limited to seven pages, with the proviso that if additional pages are desired, the author may obtain them at cost. The author may estimate the length of his paper by counting the total number of characters, including blank spaces, and dividing this by 3300. The result is the approximate number of printed pages in the Journal.

Division of the manuscripts into subheadings must follow a consistent plan, and be held to a minimum. It is desirable that a brief summary be included in all manuscripts.

Footnotes should be included in the body of the manuscript immediately following the reference, and set off by a dashed-line above and below the footnote content. Footnotes should be numbered consecutively from the beginning to the end of the manuscript.

Bibliographies (Literature Cited, References, etc.) should be arranged alphabetically according to author. Each reference should include the date, full title of the article, the name of the Journal, the volume, number (optional), pages, tables and figures (if any). For example: "Sniffen, Ernest W. 1940. Cobbles from the Pleistocene Terraces of the Lower York-James Peninsula Va. Journ. Sci., 1 (8): 235-288 1 fig., 1 tab. Reference to the bibliographic citations should not be made by numbers. Instead, using the above citations, where a reference is desired: either "Sniffen (1940)", (Sniffen, 1940: 186)", or "Sniffen (1940) states that . . ."

Explanation of figures, graphs, etc., should be typed on separate pages. All figures should be numbered consecutively beginning with the first text figure and continuing through the plates. If figures are to be inserted in the text this should be clearly indicated by writing "Figure —" at the appropriate place in the margin.

Illustrations including lettering, should be arranged so that on reduction they will not exceed the dimensions of the maximum size of a printed page. 4-1/2" x 6-1/2", and so that they are well balanced on the page. Large plates must be accompanied by 8-1/2" x 11" photographic copies which can be sent to the reviewers. The Journal will furnish the author with one plate (halftone or line reproduction) or its equivalent; additional figures, colored illustrations or lithographs may be used only if the author makes a grant covering the cost of production. Original drawings (which must be done in black drawing ink) not photographs of drawings, should accompany the manuscript. Photographs should not be used if a line and dot (stippled) drawing will suffice. If photographic prints are to be used they should be glossy, sharp and show good contrast. Drawings not neatly executed and labeled (do not use a typewriter), or which are submitted on yellow or yellowish-white paper will not be accepted.

Galley Proofs and engraver's proofs of figures are sent to the author for correction. Costs of excessive changes from the original manuscript must be defrayed by the author.

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THE VIRGINIA JOURNAL OF SCIENCE

A JOURNAL ISSUED QUARTERLY BY THE
VIRGINIA ACADEMY OF SCIENCE

**PROCEEDINGS FOR THE YEAR
1958 — 1959**



Vol. 10, New Series

September, 1959

No. 4



VOL. 10, NEW SERIES

No. 4

SEPTEMBER, 1959

THE VIRGINIA JOURNAL OF SCIENCE

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C O N T E N T S

	<i>Pages</i>
Proceedings for the Year 1958-59	
Minutes of the Thirty-Seventh Annual Meeting, May 6, 7, 8, 9, 1959	
Detailed Table of Contents	212

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VIRGINIA ACADEMY OF SCIENCE



Proceedings for the Year
1958 – 1959

MINUTES OF THE THIRTY-SEVENTH ANNUAL MEETING

MAY 6, 7, 8, 9, 1959

UNIVERSITY OF VIRGINIA

CHARLOTTESVILLE, VIRGINIA

THE VIRGINIA JOURNAL OF SCIENCE

Virginia Academy of Science

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Contents

OFFICERS AND COMMITTEES FOR 1959-60	208
MINUTES OF COUNCIL MEETING	214
MINUTES OF ACADEMY CONFERENCE	216
MINUTES OF ACADEMY MEETING	216
MINUTES OF COUNCIL MEETING	217
TABULATION OF REGISTRATION	222
REPORT OF	
Treasurer	220-221
Virginia Journal of Science	223-224
REPORT OF COMMITTEES	
Junior Academy of Science	224-231
Long Range Planning	224
Membership	234
Place of Meeting	234
Research	224
Resolutions	235
Scholarship	234
Science Talent Search	231-233
Virginia Flora	234
AWARDS	
Academy Distinguished Service	217
J. Shelton Horsley	217
Junior Academy	216, 231
Teacher Sponsor Scholarships	216, 231
MINUTES OF SECTIONS	
Agricultural Sciences	236
Astronomy, Mathematics and Physics	244
Bacteriology	254
Biology	256
Chemistry	265
Education	274
Engineering	277
Geology	289
Medical Sciences	298
Psychology	305
Science Teachers	314
Statistics	316
LIST OF MEMBERS	321
MEMBERSHIP APPLICATION	351
FORM OF REQUEST	351

MINUTES OF THE COUNCIL MEETING

MAY 7, 1959

President Forbes called the meeting to order with the following Council Members and Section representatives present: Lloyd C. Bird, R. A. Bradley, R. T. Brumfield, M. E. Carver, Walter S. Flory, Jr., T. E. Gilmer, Jr., J. W. Griswold, W. G. Guy, Boyd Harshbarger, J. T. Hack, Thelma Heatwole, William Hinton, H. H. Hobbs, J. C. Holmes, G. W. Jeffers, M. A. Kise, C. F. Lane, S. P. Maroney, Jr., S. S. Negus, B. A. Niemeier, P. M. Patterson, M. B. Rowe, W. W. Scott, F. F. Smith, J. J. Taylor, W. B. Wartman, Frank Vingiello.

Mr. Holmes reported much interest in Science Fairs in southwestern Virginia and discussions arose as to how to reach and interest the science teachers more effectively. It was decided that the President send letters to Academy members associated with the five science summer institutes asking them to encourage the science teachers from Virginia and inform them about our Junior Academy and Science Talent Search. This was put in the form of a motion by Dr. Guy and passed.

President Forbes reported the request to N. S. F. for funds to support the summer research grants for faculty members of Virginia colleges was not approved but that the visiting science program was approved. This is to be administered by the University Center in Virginia, Inc. The center requested that a committee be set up by the Academy to screen and recommend to the Center nominations that are made by the various colleges.

President Forbes suggested the following persons representing different fields of science with the idea that none would be far from Richmond, as follows: Ira Updike, S. P. Maroney, Billy Sloope, Reuben McDaniel, Richard Mitchell and Starling Reed.

Dr. Guy moved that the incoming president, Dr. Hinton, appoint this committee with President Forbes a member. This motion was passed.

Dr. Forbes announced the recipients of the Goethe Travel Award as Mr. Robert Stacey and Mr. Aaron O'Brier, both of V. P. I.

Under new business, President Forbes announced that Dr. E. C. Hoff will meet with the Council on Saturday morning and present a survey of the conclusions from the discussions of the conference on the improvement of college science teaching.

The question arose as to whether \$50 of the Goethe contributions should be continued to be applied to Student Travel to Academy meet-

ings as long as they were received. It was informally agreed that this would be done.

Foley Smith reported the annual audit had been made and reported briefly on the Academy's finances. Mr. Smith then read the Trustee's report.

President Forbes reported he had been invited to attend the Director's meeting of the 1959-60 Academy Science Programs in Washington on May 11 and Council felt he should do so.

President Forbes read the letter from Dr. Brumfield resigning the editorship of the Virginia Journal of Science.

Dr. Hobbs moved that we accept his resignation with regret and with appreciation for his outstanding services. This motion was passed.

President Forbes then read a letter from Mr. Lane resigning his position as Managing Editor of the Journal. Dr. Hinton moved we accept his resignation with appreciation for his services. This motion was passed.

Dr. Guy moved that Council extend its appreciation to Dr. Harshbarger for his continuing efforts in trying to obtain money for the Teacher-Student Conference and endorses the continuance of his efforts in this endeavor. This motion was passed.

Mr. Lane pointed out the need for a permanent storage place for the back issues of the Journal.

Dr. Jeffers stated that the State Department of Education had sent out a Statement of Policy, an item of which, curtailed students leaving school during the school week. Mrs. Heatwole said that exceptions were made for important meetings such as the Junior Academy meetings.

Dr. Bradley emphasized the need to provide housing to college and graduate students in attendance at Academy meetings at a low rate. Discussion followed with a number of suggestions but no decisions were made.

There being no further business, the meeting was adjourned.

—Paul M. Patterson, *Secretary*

MINUTES OF THE ANNUAL ACADEMY CONFERENCE MAY 7, 1959

President Forbes presided at 8 p.m., May 7, 1959, in Monroe Hall.

The Committee reports were presented and are published elsewhere in this issue. It is noted that Dr. Brumfield's report as Editor of the Virginia Journal of Science showed that expenditures were over income. Dr. Harshbarger moved that the incoming President, Dr. Hinton, be instructed to appoint a committee to look into the finances of the Journal with a view of making it solvent. This motion was passed.

—Paul M. Patterson, *Secretary*

MINUTES OF THE VIRGINIA ACADEMY OF SCIENCE ASSEMBLY MAY 8, 1959

President Forbes presided May 8 at Cabell Hall.

Greetings were given to the incoming President, Dr. William Hinton. He then introduced President-elect Edgar F. Shannon of the University of Virginia, who cordially extended greetings to the Academy. President Forbes then called on Dr. Raymond L. Taylor, Associate Administrative Secretary of the AAAS, who brought greetings to the Academy from that organization.

President Forbes asked Mrs. Heatwole to make the following announcements:

The Section of Bacteriology gave its Junior Academy of Science award in the field of microbiology to Mr. William Ridenhour, of William Fleming High School, Roanoke, and the Section of Engineering gave its Engineering Award to Mr. Lilliwhite. The Teacher-Sponsored Scholarships were awarded as follows:

The University of Virginia

Paul Caldwell, Woodrow Wilson Junior High School

Alternate: Mrs. Ruth Painter, William Fleming High School

The College of William and Mary

Mrs. Garland Conn, Newport News

Alternate: Mr. Morris Tisehler, Fairfax.

Dr. Edmund Berkeley, of the University Center in Virginia Inc., explained the administration of the Visiting Scientist Program where the National Science Foundation has granted \$6450 to provide a science speaker for a period of two days to each of the colleges in Virginia.

The Virginia Academy Distinguished Service Award was conferred on Senator Lloyd C. Byrd by President Forbes. The J. Shelton Horsley Research Award was presented to Dr. Dorothy L. Crandall of Randolph-Macon Woman's College by Research Committee Chairman, Dr. Ralph A. Bradley.

Dr. I. G. Foster presented an invitation from the Virginia Military Institute for the place of meeting of the Virginia Academy of Science in May, 1961. This cordial invitation was unanimously accepted.

Dr. Nolan Rice presented the Academy Resolutions which appear elsewhere in this issue.

Dr. Walter Flory, Jr., Chairman of the Nominating Committee, presented the following slate of officers: Secretary: P. M. Patterson, Treasurer: Foley F. Smith, Assistant Secretary-Treasurer: W. B. Wartman, Jr., Council Members: Robert C. Yates, 5 year term, Harry G. M. Jopson, 4 year term, President-Elect: Dr. Wilson Bell.

This slate was unanimously adopted.

President Forbes now introduced the speaker of the evening, Mr. S. I. Gale, of the American Cyanamide Company, who spoke on the subject: "Chemistry on a Cosmic Scale," a lecture enthusiastically received by all.

Dr. Forbes then thanked his Council, officers, and committees and others of the membership for their cooperation, then turned the meeting over to the new President, William Hinton. After a few appropriate remarks, President Hinton, on behalf of the Awards Committee, approved by Council, conferred upon Dr. Forbes the framed citation reading in part "For his many contributions to the advancement of Science, teaching, and scientific research in Virginia."

—Paul M. Patterson, *Secretary*

MINUTES OF THE COUNCIL MEETING MAY 9, 1959

President Hinton called the meeting to order with the following present.

Wilson B. Bell, R. T. Brumfield, J. C. Forbes, W. G. Guy, Ed Harlow,

Thelma Heatwole, H. H. Hobbs, E. C. Hoff, G. W. Jeffers, P. M. Patterson, F. F. Smith, W. B. Wartman.

Dr. Hoff reported on the conference held in March at M.C.V. on the improvement of college science teaching. His report centered around research by faculty, promotion of research with students and the character of the curriculum.

The subject as to how the Committee "To assist the State Board of Education in Improving the Teaching of Science and Relieving the Shortage of Scientists and Engineers" might cooperate in Dr. Hoff's venture. Mr. Harlow moved that this committee be placed under the authority of the Long-Range Planning Committee. This motion was passed.

Dr. Jeffers moved that Council express its confidence in and support of the Science Teaching Conference, initiated by M.C.V. under the direction of Dr. Hoff. This motion was passed.

Mr. Harlow pointed out that one of the staff of the Research Laboratories of the American Tobacco Company had taught an advanced course in chemistry at Thomas Jefferson High School in Richmond which had been well received. He then suggested that the Academy may help high schools approach industries seeking instructors for advanced courses in Science. Council looked with favor upon the suggestion and felt that this subject should be brought to the attention of the "Committee on Education."

With respect to the Committee to Assist the University Center in Virginia, Inc., President Hinton reported that he would appoint the Committee on Selections as recommended by retiring President Forbes with Forbes as Chairman.

With respect to finding an editor for the Journal and to study its financial condition, President Hinton felt this should be done by a Committee. It was recommended that this Committee consist of Drs. Brumfield and Hobbs.

Council recommended, in appreciation of the services of Dr. Mary Humphreys, Associate Editor of the Journal, that her outstanding contribution be recognized appropriately.

Dr. Brumfield recommended that, in the future, all abstracts of papers presented at the Academy by submitted in duplicate, and that second copy be made available for press coverage.

Mrs. Thelma C. Heatwole offered to continue as Chairman of the Junior Academy of Science Committee, in spite of the fact that she will be out of the State most of the time, if a Co-Chairman was appointed to work with her. This suggestion was approved. There followed appreciation of

her valuable work with the "junior scientists" during her chairmanship for the past 7 years.

Council went on record in expressing its appreciation for the services of Drs. Flory and Bradley, who leave Council and to Dr. Forbes for his services as President.

—Paul M. Patterson, *Secretary*

TREASURER'S REPORT
CONSOLIDATED FUND BALANCE SHEET
DECEMBER 31, 1958

ASSETS

GENERAL FUND:

Cash in bank	\$ 5,432.60	
Investments — at cost	2,445.95	
Due from Research Fund	40.00	
Total General Fund	<u> </u>	\$ 7,918.55

RESEARCH FUND:

Cash in bank	\$ 554.23	
Due from special trust fund (temporary investment)	<u>1,100.00</u>	
Total Research Fund		1,654.23

TRUST FUND PRINCIPAL:

Cash on deposit	\$ 22.24	
Investments — at cost:		
United States Savings Bonds	\$ 3,000.00	
Commercial bonds	3,025.00	
Stocks	<u>10,805.90</u>	<u>16,830.90</u>
Total Trust Fund Principal		16,853.14

Trust Fund Income

Cash on deposit	460.75
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SPECIAL TRUST FUND PRINCIPAL:

Cash on deposit	\$ 10.05	
Investments — at cost:		
United States Savings Bonds	\$ 720.00	
Stocks	<u>1,974.43</u>	<u>2,694.43</u>
Total Special Trust Fund Principal		2,704.48

SPECIAL TRUST FUND INCOME:

Cash on deposit	71.50
	<u>\$29,662.65</u>

LIABILITIES AND FUND BALANCES

GENERAL FUND:

Advance payment of dues	\$ 54.00	
James River Basin Fund	335.60	
Fund Balance	<u>7,528.95</u>	
Total General Fund		\$ 7,918.55

RESEARCH FUND:

Due to General Fund	\$ 40.00	
Fund balance	<u>1,614.23</u>	
Total Research Fund		1,654.23

TRUST FUND PRINCIPAL:

Fund balance	\$16,853.14	
Total Trust Fund Principal	<u>16,853.14</u>	

TRUST FUND INCOME:

Fund balance	460.75
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SPECIAL TRUST FUND PRINCIPAL:

Due to Research Fund	\$ 1,104.84	
Due to James River Project	<u>1,600.00</u>	
Total Special Trust Fund Principal		2,704.48

SPECIAL TRUST FUND INCOME:

Fund balance	71.50
	<u>\$29,662.65</u>

TABULATION OF REGISTRATION

Section	Members	Non-Members	Totals
1. Agricultural Sciences	16	22	38
2. Astronomy, Mathematics & Physics	36	20	56
3. Bacteriology	10	5	15
4. Biological Sciences	80	45	125
5. Chemistry	67	30	97
6. Education	7	1	8
7. Engineering	10	9	19
8. Geology	12	8	20
9. Medical Sciences	17	9	26
10. Psychology	36	25	61
11. Science Teachers	10	0	10
12. Statistics	10	11	21
No Section Preference	12	34	46
<hr/>			
Totals	323	219	542
Junior Academy of Science Registration			360
<hr/>			
Total Registration 1959 Meeting			902

FINANCIAL STATEMENT
VIRGINIA JOURNAL OF SCIENCE
May 1, 1958 — April 30, 1959

RECEIPTS:

Academy Subsidy — Members	\$3,253.81
Advertising	323.40
Subscriptions	622.95
Transferred from Savings	1,000.00
Miscellaneous	1,096.30
Total of all Receipts	<u>\$6,296.46</u>

EXPENDITURES:

Reprints	\$ 458.21
Printing	5,888.04
Postage	90.03
Stenographic	14.40
Freight	46.23
Miscellaneous (Telephone calls)	10.05
Petty Cash (See Analysis below)	65.00
Total all Expenditures	<u>\$6,571.96</u>

STATEMENT OF CASH ACCOUNT:

Cash in Checking Account — May 1, 1958	\$2,291.37
Total Receipts for Year	<u>6,296.46</u>
Total Cash in Checking Acc. during year	8,587.83
Less Total Expenditures for Year	<u>6,571.96</u>
Cash per Checkbook — April 30, 1959	2,015.87
Add Cash on Hand — Petty Cash Fund	13.46
Add Balance in Savings Account	816.10
	<u>\$2,845.43</u>

Audited by Willard G. Leeper, May 5, 1959.

VIRGINIA JOURNAL OF SCIENCE

The JOURNAL is utilized as an organ of publication by many members of the Academy, especially the Biology Section. As a result, there is a fair back-log of papers reporting the results of research. Few review articles have been submitted, however, and the help of the membership in soliciting this type of paper is requested.

— R. T. Brumfield

LONG RANGE PLANNING

Your committee has had one formal meeting during the year. No specific matter has been referred to the Long Range Committee by the Council.

The status of each of the several continuing projects is as follows:

1. The proposal of Mrs. Thelma C. Heatwole that an evaluative study be made of the Virginia Science Talent Search has not been abandoned even though the National Science Foundation could not support it. A subcommittee is now exploring other possibilities in the hope that financial aid for a study will be forthcoming.

2. The Dismal Swamp Study, under the direction of Dr. J. J. Baldwin, Jr., is making progress although it is not yet possible to suggest a completion date.

3. President Forbes has made satisfactory arrangements with State Superintendent Davis Y. Paschall for the distribution of surplus Jamestown Festival Booklets to the schools of the State. When this is accomplished we can say that the Jamestown Festival Project has been terminated.

— G. W. Jeffers

RESEARCH COMMITTEE

During the period May 1, 1958, to May 1, 1959, the following grants were made:

B. R. Woodson, Jr., Department of Biology, Virginia State College, for research on the desmids and their distribution in Virginia	\$222.00
Jesse C. Thompson, Jr. and Paul M. Patterson, Department of Biology, Hollins College, for the purchase of one pneu-	

matic deFonbrune micromanipulator for use in a number of research proposals	435.00
Total grants	657.00
J. Shelton Horsley Research Award	100.00
Total Expenditures	757.00

— R. A. Bradley

VIRGINIA JUNIOR ACADEMY

The Annual Meeting VJAS was held at the University of Virginia on May 7 and 8. One hundred and sixty-four exhibits which illustrated research projects were qualified at the JUNIOR SCIENCE DAYS for exhibit at the annual meeting.

The guest speaker at the Awards Hour was Dr. R. N. DuPuis, vice-President-Research, Philip Morris, Inc.; *Subject: SCIENCE AND THE HUMAN MIND.*

The following awards were announced at the Awards Assembly:

CLUB EXHIBITS

	Exhibit	Exhibitor	School	Sponsor
1st Place	The Role that Woodrow Wilson Junior Plays in The S. W. Roanoke Community Health	Woodrow Wilson Junior H. S. Science Club		Paul N. Caldwell
2nd Place	Many Hands of Science	Victoria Junior Science Club		Mrs. Virginia Cole
3rd Place	Projects of the Electro-Rocket Society	Warwick H. S. Science Club		Miss Dawn Irvine
HONORABLE MENTIONS				
	Avocations Related to Science	Thomas Jefferson H. S. Science Club		Miss Virginia Ellett
	Science for Everyone	Newport News H. S. Science Club		Miss Susie V. Floyd
BIOLOGY				
1st Place	An Extended Study of Anoxia as a Cause of Congenital Deformities	Baird, James K.	Wm. Fleming	Mrs. Painter
2nd Place	Comparison of Chemical and Radiological Mutations	Ridenhour, Bill	Wm. Fleming	Mrs. Painter
3rd Place	Radiosensitivity in Mice	Abbott, Sally	Jefferson Sr.	Miss Via

HONORABLE MENTIONS

Materials for Paradermal Study Roane, Ernest of Leaf Venation	Armstrong	Mrs. Gadsden
Testing the Effects of Gibberellic Acid on Algae Wheeler, Daniel D. Fairfax		Mr. Klimepeter
Induced Ovulation and Regeneration in Rana Peptiens Carter, Symore	Maggie Walker	Mr. Powell
Life Cycle of the Water Mold Dail, Peggy	Newport News	Miss Floyd
Evolution of the Gastropod Shell Harrison, Ben	Hampton	Miss Bully
Experimental Breeding of Frogs Hunter, Dale	John Marshall	Miss Hill
My Inheritance Kersey, Sandra	Hampton	Miss Bully
Red No. 32 Youmans, Marjorie	Fairfax	Mr. Tischler
A Study of Oral Bacillus and Lactobacillus Counts and Their Relation to Dental Caries Parker, Bobby	Bedford	Mrs. Thaxton
The Effects of Tranquilizers and Stimulants on White Mice Turner, Ann	Bedford	Mrs. Thaxton
The Production or Yellow Magic Penicillin Lieurance, John	McLean	Mrs. Fisher
Sea Life Churchill, Charlotte Osburn		Miss Smith
A Bio-Assay of Vitaminal Blood Serum Humbley, Bessie	Maggie Walker	Mr. Black
Hypothermia Jobin, Gary	Washington-Lee	Mr. North

PHYSICS

1st Place	Coefficient of Restitution	Hoyle, Pete	Newport News	Miss Floyd
2nd Place	Dispersion Relationship of Falling Liquids	Fisher, Stephen	Fairfax	Mr. Williams
3rd Place	Thermocouple	Young, Robert	Bassett	W. S. Waide

HONORABLE MENTIONS

Seipac	Cheek, Thomas B.	Warwick	Miss Irvine
Radio Astronomy	Bailey, Gordon	Jefferson	Miss Dickerson
The Newtonian Constant of Gravitation	Harrison, Harold	Washington-Lee	Mr. North
Can the Wear Factor of Industrial Diamonds be Increased	Brown, Mary	McLean	Mr. Rumbough
Wilson Cloud Chamber	Smith, Russell Jones, Harry	Douglas Freema	Mrs. Perkins
Electrostatic Accelerator	Rumble, Vernon	Hampton	Mrs. Thomas Mr. Rose

CHEMISTRY

1st Place	Paper Chromatography — A technique Applied in Medical Research	Weiler, Harold	Fairfax	Mr. Tischler
2nd Place	A Novel Atmospheric System for Space Flight	Lecky, W. Ralston	Thos. Jefferson	Miss Ellett

HONORABLE MENTIONS

Qualitative Protein Analysis with Burchaell, Wm.
Protein Chromatography

Fairfax

Mr. Tischler

Reactions to Contrast of Moon Tanner, Lynne
Temperatures

Hampton

Miss Bully & Mr.
D. E. Rose

Practical, Chemical & Mechanical Methods for Cleaning Laboratory & Industrial Apparatus

Hampton

Mr. Dale Rose

The Comparison and Effect of Mendelson, Elaine
Nicotine

Woodrow Wilson
(Portsmouth)

Mrs. Annie Edwards

The Study of the Acid Soluble Rose, Anne C.
Pigments in Mollusca of the

Thos. Jefferson

Miss Ellett

Species Pteris Colymbus and
Strombus Alatus

Crystal Orientation and its Effects on the Rate of Chemical Reaction

Thos. Jefferson

Miss Ellett

The Study of PH Changes in the Course of Acid-Base titration

Maggie Walker

Frederick Black

A Qualitative Study of Commercial Fertilizer

Maggie Walker

Frederick Black

MISCELLANEOUS

1st Place	Rocket Power	Rasberry, Stanley	Falls Church	Miss N. Shugrow
2nd Place	Linear Programming-Graphic Method	Boyd, Richard N.	Washington-Lee	E. M. North
3rd Place	A Study of Topological transformations and Maxima and Minima by Soap Film Experiments.	Moss, Albert	Maggie Walker	Mrs. B. Harrington

HONORABLE MENTIONS

An Investigation of the Evolution of Human Culture	Osburn (Prince Wm. Co.)	Miss Smith
A Study and Comparison of Modifications of the B-7 Gyro	T. Jeferson	Miss Ellett
Studies to Determine the Effects of Distraction on Grammar School Children	Martinsville	Mr. Sanders
An Astronomical Telescope	Schmidt, Dorn & Nelson, Jerry	Mrs. Walsh

TEACHER-SPONSOR SCHOLARSHIPS; *University of Virginia*; Paul Caldwell, Woodrow Wilson Junior High School; Alternate: Mrs. Ruth Painter, William Fleming.

College of William and Mary; Mrs. Garland Conn, Newport News; Alternate: Mr. Morris Tischler, Fairfax.

Microbiology Award: Bill Ridenhour, William Fleming; Honorable Mention: Barbara Sink, Boiling Springs High School.

Engineering Award: Malcolm A. Lillywhite, Washington-Lee High School.
E. C. L. Miller Award: Newport News Science Club.

Major W. Catesby Jones Award: Bill Ridenhour, William Fleming High School.

Honorary Memberships, American Association for Advancement of Science: Rick Owen, III, Thomas Jefferson High School, and Nancy Stoller, Newport News High School.

Honorary Memberships, Virginia Academy of Science: Frances Johnson, Maggie Walker High School, and Albert Moss, Maggie Walker High School.

SCIENCE TALENT SEARCH

The fourteenth Virginia Science Talent Search was conducted in cooperation with the National Science Talent Search. Of the one hundred and forty-four high school students who entered, eight received National Honorable Mention.

Our own reading committee considered all of the Virginia entries and selected the top forty-five as finalists to come before interviewing committees at the Charlottesville meeting of the Academy. The list of fifteen Winners and those receiving Honorable Mention will be attached to this report. All cooperating colleges and universities have received a list of the finalists. At the conclusion of this meeting they will be sent the list of Winners and Honorable Mentions.

The director is grateful for the assistance of the following who served on the reading committee: Dr. Mary E. Kapp, Dr. Jackson J. Taylor, Dr. E. Clifford Nelson, Dr. Billy W. Sloope, and Dr. William E. Trout, Jr.

Thanks are also due to the judges who helped with interviewing the finalists: Dr. W. Allen Powell, Dr. Edwin S. Higgins, Mr. Alfred L. Wingo, Dr. Mary E. Kapp, Dr. Ralph Singleton, Dr. R. M. Schatz, Dr. Billy

Frye, Mr. Edgar V. Russell, Jr., Dr. J. N. Dent, and Dr. Harold H. Garretson.

— J. C. Holmes

WINNERS OF THE FOURTEENTH VIRGINIA SCIENCE TALENT SEARCH,

- | | |
|--|---|
| 1. Baird, James Kern
2603 Tenth St. N. W.
Roanoke, Virginia | 3425 South Utah Street
Arlington 6, Virginia |
| 2. Bowler, Alicia Inez
302 Eighth St., N. W.
Charlottesville, Virginia | 9. Newman, Robert Chapman
1823 N. Nelson St.
Arlington, Virginia |
| 3. Evans, James Everett
1424 N. 12th St.
Arlington, Virginia | 10. Omohundro, Richard Eugene
2318 North Upton Street
Arlington 7, Virginia |
| 4. Grant, Donald Edd
5601 N. 36th St.
Arlington 7, Virginia | 11. Schmidt, Dorn Lewis
90 Wrightson Drive
McLean, Virginia |
| 5. Hacker, Carl Sidney
218 Chesterfield Rd.
Newport News, Virginia | 12. Shaker, Richard John
3106 N. 7th Street 1
Arlington, Virginia |
| 6. Harrison, Benjamin
4609 Victoria Blvd.
Hampton, Virginia | 13. Sounders, John Martin
Rt. No. 1, Box 425
McLean, Virginia |
| 7. Hogan, Edward Merrick
3127 N. Pollard St.
Arlington, Virginia | 14. Tomes, Charles Forrest
8359 Halesworth
Richmond 25, Virginia |
| 8. Lintner, Michael Alan | 15. Winsor, Niels Karl
3017 — 4th Street
Arlington 1, Virginia |

VIRGINIA SCIENCE TALENT SEARCH.

HONORABLE MENTION IN THE FOURTEENTH

- | | |
|---|--|
| 1. Baroody, Roger Anis
203-D East Nelson Street
Lexington, Virginia | Falls Church, Virginia |
| 2. Brewer, William F.
4 Eppard Street | 3. Broadus, Paul Farwell
Route No. 2, Box 128
Nokesville, Virginia |
| | 4. Cassada, Thomas Edward |

- 532 Woods Ave.
Roanoke, Virginia
5. Donohew, Jack Norman
4311 North 24th Street
Arlington 7, Virginia
6. Dowling, Walter J.
Laurel Ridge Road
Vienna, Virginia
7. Fisher, Stephen David
Box 418, Rt. 1
Fairfax, Virginia
8. Gearhart, Clayton Alan, Jr.
Route 3 — Box 180
Fairfax, Virginia
9. Hambrick, David Paul
1401 Cove Rd. N. W.
Roanoke, Virginia
10. Hamilton, MacKenzie Lee
3335 N. Randolph Street
Arlington, Virginia
11. Harrison, Harold Roger
2400 N. Nelson St.
Arlington, Virginia
12. Long, Patricia Ann
3603 Missouri Ave.
Richmond 22, Virginia
13. Mason, James Porter
Eagle Rock, Virginia
14. McMurray, Morland John
1329 Rugby Road
Charlottesville, Virginia
15. McNally, James Klueh
Quarters 407 A.
Fort Belvoir, Virginia
16. Parrish, Russell Vaughan
2000 Roanoke Ave.
Newport News, Virginia
17. Patterson IV, John Laird
417 Gilbert Street
Hampton, Virginia
18. Rasberry, Stanley Dexter
201 Lawrence Drive
Falls Church, Virginia
19. Remington, Bruce
11 Tauxemont Road
Alexandria, Virginia
20. Roop, Joseph McLeod
Route 1
Clifton, Virginia
21. Rose, Anne Clairborne
1010 Westwood Ave.
Richmond 27, Virginia
22. Rucker, Diane Elise
3139 — 18th St., North
Arlington 1, Virginia
23. Salmon, William Irwin
800 N. Wayne St., No. 304
Arlington 1, Virginia
24. Shumate, Paul William
Rt. No. 3, Box 540
Fairfax, Virginia
25. Starbird, Susan Evelyn
2401 N. Taylor Street
Arlington 7, Virginia
26. Stoller, Nancy Elaine
37 Alleghany Rd.
Hampton, Virginia
27. Turpin, William Craig
1410 Noland Road
Falls Church, Virginia
28. Welles, Judith Evelynne
Box 350R — Rt. No. 1
Oakton, Virginia
29. Wharam, Moody Dewitt
1405 N. Wakefield Street
Arlington, Virginia
30. Wood Jr., Gilbert Nathaniel
R. F. D. No. 2
Farmville, Virginia

VIRGINIA FLORA

Members of the Committee keep plugging away in spite of academic responsibilities. Professor Freer continues his activities in the Central Blue Ridge area, Dr. Patterson is active in his investigation of the moss flora. Different members of the Committee have continued to promote interest in the flora by means of illustrated lectures and journal articles. A second edition, slightly revised, of the bulletin on Virginia Ferns and "Fern Allies" has been issued and a third edition of the bulletin on Poisonous Plants will be available in May. Dr. Clyde F. Reed of Baltimore has made a special study of the ferns of the Northern Neck area. His data giving details of his field investigations are presented in a paper in *American Fern Journal*, Vol. 49, pages 30-36. This is a welcomed contribution. Massey has been granted the privilege of continuing his work on the State flora at V.P.I. as Professor of Botany Emeritus, Curator of the Herbarium. Freed of academic duties he will give his entire attention to his objective — Flora and Economic Botany of Virginia — and extending the herbarium which now contains some 25,000 specimens from all parts of the State.

— A. B. Massey, Chairman

PLACE OF MEETING

The Virginia Military Institute has cordially invited the Virginia Academy of Science to hold its 1961 meeting at Lexington, Virginia.

— I. G. Foster

BUSINESS MEMBERSHIP

The Academy has eleven business members. Efforts were made to obtain additional business members to support the work of the Academy but no concentrated campaign was initiated. It is the intention of the Committee to make a more all-out effort during the coming year.

— E. S. Harlow

SCHOLARSHIP

No senior high school student, who is considered by his teachers as having the ability and aptitude to continue his formal education, need be prohibited nowadays from attending college by financial considerations

alone. This is *especially* true if the high school senior is proficient in biology, chemistry, physics, and mathematics as well as in subjects like English and history. Added to this proficiency, however, must be the initiative and determination on the part of the needy student to find out for himself how he can help his parents to make possible his college education.

During the past year, the scholarship committee of the Academy has had only 32 high school seniors ask its advice about college scholarships. Fortunately all but one of these had definite aptitudes for scientific careers and were recommended to the colleges of their choices for financial aid. All of them received scholarships ranging from \$200 to \$1200. In no case, did the committee recommend a student to more than one college.

One reason why this committee is not consulted more is probably because high school teachers are doing such good jobs in securing college scholarships for their better students who need financial aid. There are also many teachers of scientific subjects in colleges who are quietly seeking brilliant high school students for their respective colleges. They learn of them by way of the State Science Talent Search and the Virginia Junior Academy of Science activities. Often a top winner at the annual science exhibit of the Junior Academy and/or the Talent Search is offered as many as six scholarships. Academy members are doing exceptionally well in securing financial aid for high school seniors to continue their scientific studies in colleges. This particular committee, however, cannot claim much of the credit.

— Sidney S. Negus

RESOLUTIONS

1. Whereas the concept of organic evolution has contributed greatly to the advancement of science and promises even greater advancement for the future, and

Whereas the year 1959 marks the one hundredth anniversary of the publication of the *Origin of Species* by Charles Darwin, and

Whereas the Virginia Academy of Science was instituted for the discovery and dissemination of scientific knowledge,

Therefore be it resolved that the Virginia Academy of Science hereby recognizes this monumental work in tribute to the man and in commemoration of the date.

2. Be it further resolved:

That the Academy records with sorrow the loss by death of the followings members: Dr. Edwin M. Betts, Dr. J. K. Finnegan, Mrs. Lillian A. Hughes, Mrs. W. R. Nance, and Mr. J. Worth Pence, and

3. That the Academy extends its thanks in grateful appreciation to its host, the University of Virginia, and for the exceptionally fine facilities and arrangements for this meeting, and especially for the tea, and to the Local Committee on Arrangements headed by Dr. S. P. Maroney, Jr., and his able assistants, namely: Drs. Jacques Rappaport, William C. Lowry, Richard McKinsey, Kenneth Llyod, Bartholomeus Van't Riet, and Starling Reid, and

4. That the Academy acknowledge with appreciation the efforts of commercial and educational exhibitors, and

5. That the Academy is deeply indebted to President John Campbell Forbes for his tireless, enthusiastic, and devoted leadership and to the other officers both General and Sectional for their whole-hearted co-operation in making this a highly successful meeting.

Everett H. Ingersoll

George W. Jeffers

Nolan E. Rice, *Chairman*

MINUTES OF THE SECTION MEETINGS

AGRICULTURAL SCIENCES

1. A 26-YEAR WEATHER SUMMARY AT HOLLAND, VIRGINIA.

D. L. Hallock; *Virginia Agricultural Experiment Station.*

Certain temperature and precipitation records obtained at the Tidewater Research Station were presented. Generally, rainfall distribution and temperatures are favorable for good crop production. Extreme temperatures of 105°F and -3°F occurred during the 26-year period. The hottest month is generally July, and the coldest January. The average number of days per year with maximum temperatures of 95°F or above was 11. The frost free growing season approximates 195 days. Killing frosts have occurred as late as May 11 and as early as October 2. Annual precipitation was approximately 48 inches. Normally more than 17 inches of rain falls during June, July, and August, but its distribution is frequently sporadic. The largest rainfall during 1 day was 6.4 inches, during 1 month, 15.6 inches. The mean annual snowfall is 8 inches, however as much as 22½ inches have been recorded.

2. SOME NEW CULTURAL TECHNIQUES WITH STRAWBERRIES IN EASTERN VIRGINIA.

M. M. Parker; *Virginia Truck Experiment Station.*

Current cultural experiments at Norfolk deal primarily with the performance of transplants set in the field at times other than the customary commercial planting time in early spring. Concurrently the experiments deal with systems of production and dates of planting.

Results: 1. Satisfactory yields of extra good quality fruit resulted the next spring following setting out one-year-old Pocahontas plants in hills in early November. 2. Similar quality fruit with perhaps better yields were obtained from stored plants set in hills in mid-August. 3. Poor results followed the use of two-year old plants dug and set after they had produced a crop of fruit.

3. THE DEVELOPMENT OF F₁ SPINACH HYBRIDS ADAPTED TO EASTERN VIRGINIA.

E. A. Borchers; *Virginia Truck Experiment Station.*

Field tests of numerous experimental F₁ spinach hybrids have shown that many hybrid combinations produce an appreciably larger yield than the standard commercial varieties. While most of the hybrids which exhibit the greatest vigor also possess undesirable horticultural characteristics, limited tests have indicated the possibility of obtaining hybrids with increased yielding ability and disease resistance which will be horticulturally acceptable in Tidewater Virginia. By means of controlled pollination procedures in the field and greenhouse, inbred lines and experimental hybrids are being developed and evaluated at the Virginia Truck Experiment Station with the goal of developing superior spinach hybrids for Eastern Virginia.

4. SOME NEW ASPECTS OF POTATO INSECT INVESTIGATIONS IN SOUTHEASTERN VIRGINIA.

R. N. Hofmaster; *Virginia Truck Experiment Station.*

Soil treatments with aldrin or heptachlor at 2.5 pounds actual/A. or dieldrin at 1.5 pounds actual/A. showed reductions of 92, 94, and 87 percent, respectively, in flea beetle damage to Irish potato foliage after three seasons. Soil treatments with these insecticides were effective against the Colorado potato beetle only during the first season. Irish potato varietal studies as related to the intensity of damage by flea beetles, wire worms, leaf hoppers, and associated pests have been conducted since 1953. These studies demonstrate a definite correlation between variety, leaf hopper control and tuberworm damage to tubers in the soil.

5. ENGINEERING USE OF PEDOLOGICAL SOILS INFORMATION.

Arnold C. Orvedal; *Soil Scientist, Soil Conservation Service, USDA, Beltsville, Md.*

Although both soil science and soil engineering deal with soils, these disciplines have developed rather independently. As a result, we today have two fundamentally different concepts of soil, two kinds of soil classification systems, and two sets of terminology. We therefore have obvious difficulties in communication. At the same time soil scientists have much to contribute and engineers have much to gain from pedological soils information. Widespread improvement is now taking place in mutual appreciation, understanding, and cooperation between engineers and soil scientists. As a result, pedological information, especially soil surveys, is being used more and more for engineering purposes, but the full potential is not yet generally realized.

6. RATES AND TYPES OF GROUND LIMESTONE FOR ALFALFA.

George D. Jones and W. W. Moschler; *Virginia Agricultural Experiment Station.*

Low rates of lime on Tatum silt loam is resulting in low yields and early death of alfalfa stands. Dolomitic limestone is slightly but consistently outyielding the calcic limestone, notwithstanding the fact that the calcic stone is more chemically reactive as evidenced by soil tests at intervals following application. No alfalfa lived where lime was not applied, 250 pounds per acre was only sufficient to start it, 500 pounds lasted about one year, and 1000 pounds lasted about two years. There is evidenced that 2000 pounds will last about three years, and higher rates in proportion.

7. 2-3-5 TRIPHENYL TETRAZOLIUM CHLORIDE AS A QUICK TEST IN DETERMINING VIABILITY OF SMALL GRAIN SEEDS.

T. G. Copeland, Jr., and C. F. Bruce; *Division of Plant Industry
Virginia Department of Agriculture*

Standard germination tests evaluate the performance of seed under artificial and optimum conditions. Due to the time factor for such tests, the Department has been searching for a quick seed viability test. We believe that the chemical 2-3-5 Triphenyl Tetrazolium Chloride offers a partial answer. When normal respiration processes take place in the living cells of the seed embryo, free hydrogen is released which will reduce tetrazolium Chloride offers a partial answer. When normal respiration processes take place in the living cells of the seed embryo, free hydrogen is released which will reduce tetrazolium chloride to a reddish compound (2-3-5 triphenyl formazan). Dead cells do not release hydrogen and from the red color. This enables the analyst to observe the viability of the individual parts of the embryo.

8. TRENDS IN FERTILIZER TECHNOLOGY.

W. L. Hill; *Fertilizer Materials Section,*

Soil and Water Conservation Research Division, USDA, Beltsville, Md.

Fertilizer manufacture involves large tonnages of materials. The domestic industry moved nearly 23 million tons to farms in the year ended June 30, 1957. The techniques of production, one of three interlocking agricultural technologies—fertilizer making, soil management and crop production, is concerned with winning suitably-reactive, nutrient-bearing compounds in uniform, stable and free-flowing assemblages designed to meet crop needs in particular market areas. Noteworthy changes in modes of operation are witnessed by continuous increase in purity of products, by methods for closer characterization of raw materials and products, by integration of manufacturing sequences, and by expansion of production into new market areas with facilities that employ advanced techniques.

9. WOODCHUCKS: A MAJOR AGRICULTURAL PEST IN VIRGINIA.

John C. Jones; *U. S. Department of the Interior.*

Woodchucks, or groundhogs are causing serious losses to nearly all types of agriculture in most sections of Virginia. Their numbers appear to have increased markedly in the past 10 years and the range has spread, particularly in eastern counties. Forage crops, especially alfalfa and soybeans, and vegetable crops are major sources of food. Burrows are damaging to fields and pastures, causing erosion, frequently damaging machinery and occasionally breaking legs of stock. Orchard and nursery stock is commonly clawed, chewed and damaged. Control is relatively simple, by gas, in spring of the year when burrows are first opened.

10. NUTRITIONAL STATUS OF RURAL HAITIANS.

K. W. King and G. L. Brinkman; *Virginia Polytechnic Institute.*

During the summer of 1958, the nutritional status of rural Haitians was evaluated by a 20-member team of Haitians and Americans. Data of the following types were obtained: general indices of the economy, social structure and health; actual and potential agricultural production; food consumption through interview; medical examinations of 3,000 people aged 5 to 75 years old for clinical evidences of malnutrition, and biochemical analyses of blood and urine specimens from 500 of these patients for specific nutrients and excretion products. The general nutritional status of the population was summarized. Interactions between the nutritional problems and economic relapse, primitive agri-business, public health, political instability, and social custom were discussed.

11. PURIFICATION OF THE GROWTH FACTOR IN MEAT MEAL.

P. Lepore and C. J. Ackerman; *Virginia Polytechnic Institute.*

When rats are fed sulfaguanidine in an otherwise complete diet, growth ceases after the 4th week. When meat meal or certain animal tissues are included in such diets, growth is almost normal. Purification of the growth promoting activity consists of acid hydrolysis followed by acetone extraction of the acid insoluble residue. The addition of water to the acetone extract results in the separation of an active paracitrate. Addition of $\text{Ba}(\text{OH})_2$ to the filtrate yields a precipitate and a filtrate which are both active in promoting the growth of sulfaguanidine-fed rats.

12. THE INFLUENCE OF DOMINANCE RANK OF SEXUAL ACTIVITY OF CHICKENS.

P. B. Siegal; *Virginia Agricultural Experiment Station.*

An experiment was conducted to determine the influence of peck rights on the sexual activity of White Rock cockerels in multiple male-matings. Results indicate differences between male groups and between males within groups for sexual activity as measured by number of courts, mounts, treads and completed matings. Interferences for mounts and treads were not uni-directional (interference by a dominant male to a subordinate one) whereas interferences for courts were, indicating a loss of recognition during the mating act. Also, males which were highest in the social hierarchy did not necessarily have the greatest drive.

13. THE EFFECTS OF EQUINE GONADOTROPHINS ON VARIOUS REPRODUCTIVE PHENOMENA OF THE EWE.

G. H. Kiracofe and J. W. Gossett; *Virginia Agricultural Experiment Station.*

Pregnant Mare Serum was used in this project to study its use as a factor to produce superovulation and thereby produce higher lambing rates among ewes. It was found that ovulation rates, number of live embryos at 40 days, and number of lambs born were increased in the injected ewes. Conception rates, estrus cycles and vitality of the lambs were not affected by the hormone treatment. Although P.M.S. can be used to increase lambing percentages, the increase came not from an increased frequency of thinning, but from the number of triplets and quadruplets produced.

14. THE EFFECT OF CERTAIN FEED ADDITIVES AND FEED PREPARATIONS FOR FATTENING FEEDER LAMBS.

H. A. Hopkins, J. P. Fontenot, W. M. Mestanza and J. S. Copenhaver;
Virginia Agricultural Experiment Station

The effect of feeding 2 mg. stilbestrol per head daily and 10 mg. aureo-

mycin (chlortetracycline) per pound of feed, alone and in combination, and of grinding and pelleting hay, pelleting corn and pelleting the entire ration was studied in 90 fattening feeder lambs. There was a trend for aureomycin feeding to depress rate and efficiency of gain and for stilbestrol feeding to increase these. Grinding the hay increased feed intake, and rate and efficiency of gain. Pelleting increased feed efficiency. A much higher incidence of rumen parakeratosis, a pathological condition, was observed in lambs fed pellets than in those not receiving pellets.

15. CELL DIVISION IN ACTIVELY GROWING FOLLICLES AND THE CHROMATIN REACTION IN THE SKIN OF SHEEP.

Lubow A. Margolena; *Sheep, Goat and Fur Animal Research Branch, A.R.S., Beltsville, Maryland*

Mitotic counts in matrices of actively growing wool follicles and observations on the chromatin reaction in skins and follicles of merino and Hampshire sheep were carried out throughout the seasons at Beltsville, Maryland. In both breeds, mitoses averaged about 70% higher in early and mid summer than in the winter months. Spring and summer specimen exhibited pronounced chromatin reactions (Feulgen), while winter biopsies proved to be practically achromatic. Hence, provided nutrition is adequate, the rate of growth of the wool fiber is expected to depend on the season of the year.

16. USE OF ELECTRONIC DATA COMPUTING METHODS TO ANALYZE THE BASIC SURVEY OF VIRGINIA DAIRYING.

Robert F. Hutcheson; *Virginia Department of Agriculture.*

A basic survey of Virginia dairying is being jointly conducted by the Virginia Department of Agriculture and the Virginia Agriculture Extension Service. Questionnaires for the studies are pre-coded for rapid analysis by electronic data computing methods. As a result, a very detailed picture of the size, volume, methods, equipment and economic and social factors having to do with Grade A dairying has developed. Also, the first thorough picture of the markets, market organization, and farm to market patterns has been portrayed. Information is available on a county, district and state wide basis as well as by markets and marketing organizations.

17. THE ECONOMICS OF FEEDING GRAIN TO MILKING COWS ON PASTURE.

W. A. Hardison and G. C. Graf; *Virginia Agricultural Experiment Station.*

Two grazing trials were conducted to study the effect of supplementary grain feeding of cows on pasture. In both trials the cows grazed, rotationally, on orchard grass ladino clover mixture of high quality. Trial 1 ground shelled corn and a simple 16% TP supplement were compared with

no supplement. A mixture of corn and oats, a simple 16% TP supplement, and no supplement were compared in Trial 2. Only in the instance when a mixture of corn and oats was fed in Trial 2 did supplementary feeding result in enough extra milk produced to pay for the supplement.

18. PROGRESS REPORT ON RESEARCH ON DWARFISM IN BEEF CATTLE.

T. J. Marlowe, D. F. Watson, and N. O. Price;
Virginia Agricultural Experiment Station.

Studies on dwarfism at V.P.I. have been pointed toward the pathology of the dwarf. Complete necropsies of 23 dwarf and 10 normal calves revealed several gross abnormalities; however, histological examination failed to reveal any striking differences. Dwarf x dwarf matings always produce dwarfs. Bioassays for thyrotropic, ACTH and gonadotropic hormone revealed no significant differences between dwarf and normal calves. Blood analysis for PBI, glucose, calcium, phosphorus, magnesium and phosphate activity failed to yield significant differences. Present research is directed toward morphological site of gene expression, period it operates, and mode of action by studying known genotypes during early fetal development.

19. PRELIMINARY INVESTIGATION OF THE FERMENTATION OF UNIFORMLY LABELLED C¹⁴-GLUCOSE BY RUMEN MICROORGANISMS.

J. H. Newman and W. E. C. Moore;
Virginia Agricultural Experiment Station.

Samples of rumen fluid were incubated with uniformly labelled glucose for 11½ hours in a closed system. Distribution of activity in both unfermented control samples and fermented samples was determined among protein and particulate material, ether extractable substances, amino acids, and peptides, sugars and other neutral molecules, carbon dioxide, and methane. Samples counted as barium carbonate followed wet oxidation indicated 80 to 85% C¹⁴ recovery, with additional losses in some individual fractions. Data indicate differences between fermentation activity in samples from two animals. Major C¹⁴ products include protein and cells, ether extractables, and carbon dioxide (29, 10.5, and 15.6%, animal 1; 14.5, 23.5, and 14.3%, animal 2).

20. THE EFFECT OF IMPLANTING DIFFERENT LEVELS OF STILBESTROL IN GRAZING BEEF STEERS.

J. P. Fontenot, R. F. Kelly and J. A. Gaines;
Virginia Agricultural Experiment Station.

At the beginning of each of two grazing seasons, 5 groups of 8 steers each were implanted, in the ear, with the following levels of stilbestrol: 0,

12 mg., 24 mg., 36 mg., and 48 mg. A 12 mg. implant increased rate of gain 20% ($P < .01$). Increasing the level of stilbestrol above 12 mg. did not further affect gain significantly. When 12 mg. of the drug were used carcass grade was not affected. When the level was increased to 36 and 48 mg. a decrease in grade resulted ($P < .05$). When the level of stilbestrol used was 24 mg. or higher chemical composition of the meat was affected.

21. EFFECTS OF SELECTED PHYSICAL AND ECONOMIC VARIABLES ON PRICES OF CALVES IN VIRGINIA FEEDER CALF SALES.

K. C. Williamson, R. C. Carter, G. W. Litton, J. D. Johnson, and
J. A. Gaines;

Virginia Polytechnic Institute

Records of 21 Virginia Feeder Calf Sales held annually from 1951 through 1956, were studied to determine the effect of certain selected variables on the average prices received for calves. Effects of the variables studied were estimated by the least squares method with separate analysis for steer and heifer calves. The breed, weight, and grade had rather large statistically significant effects on the price of both steer and heifer calves. The price of steer calves was also significantly effected by the size of the sale and size of the sale lot but not the heifer calves.

Business Meeting

Officers elected for next year: Chairman, Maurice B. Rowe; Vice-Chairman, W. H. Brittingham; Secretary, Carl W. Allen; Editor, (3 Year Term), P. B. Siegel.

In other business, ways and means of getting broader support to further the usefulness of the section were examined. The possibility of joint sessions, sub-sections on narrower areas of work, e.g., crops and soils, feeds and nutrition, and obtaining the whole-hearted backing of the agricultural leaders in the State were discussed. These are to be considered in building the program for the 1960 meeting.

ASTRONOMY, MATHEMATICS, AND PHYSICS

1. THE EQUILIBRIUM ULTRACENTRIFUGE.

Charles E. Williams, Richard D. Boyle, J. W. Beams;
University of Virginia

A description of the magnetically supported ultracentrifuge is presented. It can be applied to the problem of molecular weight determination by the sedimentation equilibrium method. The equipment used consists of a 29 pound steer rotor, spinning at speeds of 400 r.p.s. in a vacuum chamber. A dilute solution of the sample being studied is placed in a sector shaped cell contained in the rotor. The rotor is accelerated by means of an air turbine and allowed to coast until the rate of sedimentation and the rate of diffusion of molecules balance each other, thus establishing a condition for equilibrium. Measurements of concentration distribution within the cell are made from a changing interference pattern of a Jamin type interferometer.

2. FAST PHOTO-NEUTRONS FROM TANTALUM AND GOLD.

L. B. Aull and G. C. Reinhardt;
University of Virginia

The yield and angular distribution of photo-neutrons from tantalum and gold with energies above the $\text{Si}^{28}(\text{n},\text{p})$ threshold have been measured with bremsstrahlung from the University of Virginia synchrotron. Cylindrical silicon detectors were mounted coaxially with the sample being irradiated, and the resultant Al^{28} activity determined. The integrated cross section for both elements was about 400 mb-Mev. to 30 Mev., and 800 mb-Mev. to 64 Mev. The angular distribution for both elements fitted approximately a curve $(a + b \sin^2 \theta + c \cos \theta \sin^2 \theta + d \cos \theta)$.

3. PHOTO-PROTON YIELDS FROM LIGHT ELEMENTS.

D. C. Worth and G. R. Haste;
University of Virginia

Using high energy X-rays from the University of Virginia synchrotron, various investigators are studying "photonuclear" re-actions (in which X-ray energy absorbed by a target nucleus results in emission of one or more nucleons). Photoneutrons are generally more abundant than photoprotons from medium and heavy elements, but investigation of how either type of emission varies with X-ray energy can give important information about nuclear processes involved in photo-absorption and emission. This paper outlined experiments for the direct counting of photoprotons from several

light elements (especially carbon and lithium) by means of thin scintillation crystals, and presented some preliminary results.

4. ANGULAR DISTRIBUTIONS OF 15 MEV NEUTRONS ELASTICALLY
SCATTERED BY LIGHT ELEMENTS.

B. C. Groseclose, R. F. Stetson, and W. W. Walker;
University of Virginia

Angular distributions of 15 MEV neutrons elastically scattered by O, Mg, and Al have been measured up to 130° . An angular distribution was also done for Mg at 14 Mev to investigate possible anomalous energy variations in the differential cross section. A ZrT target was used to produce neutrons by means of the $T(d,n)He^4$ re-action. The neutron beam was electronically collimated by time-of-flight techniques and the data recorded on a 20-channel analyzer, gated by the $n-\infty$ coincidences. The data are compared with the theoretical optical model calculations of Bjorklund and Fernbach. The agreement with theory is very good. No anomalous changes for Mg were found.

5. DEMONSTRATIONS OF PARITY CONSERVATION.

Frank L. Hereford and John S. Plaskett;
University of Virginia

Simple demonstrations of parity conservation in electromagnetic interactions were given, which are suitable for elementary physics courses.

6. A PRECISION 0-20 AMPERE MAGNET CURRENT CONTROL.

M. W. Chramiec and C. D. Bond;
Virginia Polytechnic Institute

The use of field regulated generators as stable current sources for low impedance analyzing magnets is now rather extensive and both design considerations and detailed circuits are well treated in the literature. The advantages of the system described here allows one to use commercially available units together with a relatively simple feed-back circuit to achieve a stability of ± 5 parts in 10^5 at full output. The current level can be varied, set and measured to <0.01 amperes with a single control. Regulation is automatically monitored and maintained indefinitely.

7. A WATER-MODERATED NATURAL URANIUM SUB-CRITICAL REACTOR.

T. H. Row and Andrew Robeson;
Virginia Polytechnic Institute

A reactor system of this type was added to the Reactor Laboratory

facilities because of its extensive use in power reactors. The advantages of the system are numerous and include variation of moderator temperature, addition of moderator poison, and variation of lattice geometry and orientation. The disadvantages associated are the inability to measure critical size and the corrosion problems arising from the use of tap water. The rectangular steel tank used for the containment vessel has positioning apparatus for the Plexiglass tube sheets. Either a horizontal or vertical lattice of the aluminum fuel elements can be arranged. The experimental work includes determining the relation of material buckling to moderator temperature, moderator poison, and moderator to fuel volume ratios. A calculation of the multiplication factor for the system was made and found to be 0.5325.

8. OBSERVATION OF THE DECAY OF ADSORBED BARIUM — 133 IN THE FIELD EMISSION MICROSCOPE.

William C. Saunder; *Virginia Military Institute*

An experiment is proposed to determine if the characteristic granulation of the field emission image of small amounts of barium adsorbed on tungsten arises from individual barium atoms or circular clusters of barium atoms. Barium — 133, which decays by electron capture to become stable Cesium — 133, will be employed as the adsorbate. It is shown theoretically that if the granulations are blurred images of individual atoms, as an atom of Barium — 133 decays, the corresponding image of the atom will be intensified by a factor of two or three. However, if the granulations are due to circular clusters 40 to 200 angstrom units in diameter, the image intensification will amount to less than 10% as the Barium — 133 decays. A brief theoretical investigation indicates that the recoil of the adsorbed atom during decay will not affect the validity of the experiment.

9. DIVISIBILITY TESTING.

Herta T. Freitag; *Hollins College*

Arthur H. Freitag; *Jefferson High School*

This procedure establishes the divisibility of any natural number N by any other natural number p whenever $N = O(p)$. The quotient N may also be determined by this device. If $N = r(p)$, $r = O$, then r is obtainable (to be presented in a later paper.) This method may be of some interest because (a) of the number properties involved; (b) of its simplicity; (c) a quotient may be found without the operation of division (or of successive subtractions of the divisor from the dividend.)

10. SOME ASPECTS OF TERMINAL BALLISTICS.

Robert L. Kernell; *College of William and Mary*

In testing a formula for the penetration of projectiles in a target of brittle spheres, it became necessary to determine the size distribution of fragments created by comminution. After passing the fragments through graded sieves, the diameters of the smaller fragments were measured with a microscope. These results were normalized and combined with the average diameters of the larger fragments. A plot of dN/ds against s (where N is the number of fragments and s is the diameter) was used to numerically integrate $\int s^2 \frac{dN}{ds} ds$ and $\int s^3 \frac{dN}{ds} ds$. This permitted evaluation of the mean fragment diameter from which the surface area created by comminution could be calculated.

BUSINESS MEETING.

The Astronomy, Mathematics, Physics Section business meeting was held at 11:45 A.M. Friday, May 8, 1959 in the Large Auditorium of the Physics Building of the University of Virginia. The following officers were elected by unanimous vote: *Chairman*, Robert C. Yates (William and Mary); *Secretary*, Andrew Robeson (Virginia Polytechnic Institute). There was discussion of the question concerning the formation of a separate section of Mathematics which was tabled. Miss Isabel Boggs reported progress on her work pertaining to the History of Science in Virginia. I. G. Foster was commended for faithfulness as section editor.

11. CURVATURES OF $r^n = \cos n\theta$.Robert C. Yates; *College of William and Mary*.

The Lemniscate, the Hyperbola, the Cardioid, and the Parabola are the curves of $r^n = \cos n\theta$ for $n = 2, -2, \frac{1}{2}, -\frac{1}{2}$, respectively. Assuming constructibility of multisection of angles then tangents, normals, and centers of curvature of these familiar curves have surprisingly simple constructions. Techniques are based upon the expression $\tan \psi = r/r'$ and $R = ds/da$ where a is an inclination of the tangent.

12. PROBABILITY FOR HIGH SCHOOL STUDENTS.

Beatrice A. Harrington; *Maggie L. Walker High School*

The members of our mathematics club made a study of the theory of probability, first restricting our mathematical models to sample spaces having a finite number of outcomes. We then performed an experiment resulting in an infinite number of outcomes. Three players tossed a die

in turn with the winner being determined by the appearance of a "1" or a "6". We played the game 700 times and compared the predicted frequency of occurrence of certain events according to probability theory, with our observed results. We were gratified with our findings.

13. A LABORATORY FOR LIBERAL ARTS PHYSICS.

John Lacy McKnight; *College of William and Mary*

In conjunction with a course in physics for liberal arts students, we have attempted to conduct a laboratory which would give the student an opportunity to repeat some historically important experiments under conditions like those under which the original experiments were conducted. In these, the student is referred to the original description of the experiment in his text and/or primary sources. We are attempting, as well, to show the logical aspects of physics and to demonstrate some of the phenomena omitted in our lecture outline. In these experiments equipment is kept as primitive as possible and only one principle is introduced at a time.

14. HISTORICAL AND PHILOSOPHICAL EXPERIMENTS IN ELEMENTARY PHYSICS.

Richard H. Prosl; *College of William and Mary*

15. THE JUNIOR INSTRUCTORSHIP PROGRAM AT WILLIAM AND MARY.

R. C. Yates, Garret Etgen, and Richard H. Prosl;
College of William and Mary

The program of student-teaching at William and Mary was discussed by two of the student participants and the directing professor. Each student-teacher performed all duties of instruction of one section of freshman mathematics throughout the year. The supervising professor attended each class meeting for observation, and held conferences with the student-teachers before and after each class. All tests, examinations, and grades were supervised with the professor as final responsibility. Student teachers were paid a nominal fee for their work, but were not awarded academic credit. Citations were installed on their academic transcripts.

16. EXPERIMENTS FOR ADVANCED UNDERGRADUATES.

W. D. Whitehead; *University of Virginia*

A series of experiments have been developed for an Honors laboratory section in elementary physics, one of these is the measurement of the range energy relationship of a metal washer on a table top. The experiment is divided into three parts, the energy calibration of the "ac-

celerator" which is a heavy pendulum that strikes the washer, the measurement of the range energy relationship on a table top, and the analysis of energy and momentum relationships for collisions of washers on the table top. The experiment is very instructive both in classical mechanics, and in giving the student some idea of the methods used in nuclear physics experiments.

17. AN APPARATUS FOR THE MEASUREMENT OF THE RANGE OF AN ALPHA PARTICLE IN AIR.

James Little; *College of William and Mary*

Alpha particles of a given energy have a well defined range in air. This range and the specific ionization in the path can be measured with this instrument. The ions formed between a charge grid and a collector plate are measured with a current shunt on an electrometer. A Bragg curve is obtained by plotting position *vs.* current. When used with Polonium 210 the range was found to be slightly higher than literature value.

18. AN INTERMEDIATE LABORATORY EXPERIMENT ON RUTHERFORD SCATTERING OF ALPHA PARTICLES.

E. T. Gerry; *College of William and Mary*

Scattering experiments are of fundamental importance in nuclear physics. Rutherford scattering is of historical importance since the results of these early scattering experiments brought about the acceptance of the nuclear model of the atom. Such experiments also give information as the size of the nucleus. It was desired to develop an experiment on Rutherford scattering for use in an intermediate level nuclear physics course. Apparatus using a scintillation screen and photomultiplier tube for measurement of count rate versus scattering angle is described. Typical results are presented.

19. AN ANALOG COMPUTER USED IN REACTOR SIMULATION.

Wm. S. Baber and Andrew Robeson; *Virginia Polytechnic Institute*

A compact analog computer developed by the Heath Company has been built and used to extend the range of operation of the Virginia Polytechnic Institute Nuclear Reactor Simulator. A variable temperature coefficient is simulated on the computer by utilizing a signal from the reactor simulator, performing the necessary operations and then feeding the resultant signal back to a bus on the reactor simulator. Some techniques of reactor simulation were discussed.

20. SIMULTANEOUS PHOTO-ELECTRIC EFFECT OF TWO ELECTRONS.

Frederic R. Crownfield; *College of William and Mary*

Since it is quantum mechanically impossible to distinguish between two electrons, it is not surprising that there should be processes in which two or more electrons in the same atom undergo transitions simultaneously. The simplest approximate wave functions for helium, for example, give a null result for the probability of such a transition. Calculations with somewhat improved wave functions, however, do not give such a result. The calculation of the transition probabilities for simultaneous transitions were outlined and possible experimental methods for verifying the theory were discussed.

21. UNFAMILIAR FACTS CONCERNING THERMOELECTRICITY.

L. G. Hoxton; *University of Virginia*

The recent revival of research in thermoelectricity, occasioned initially by studies of the properties of semiconductors, is not unfamiliar to many. Yet it is assumed that some details of developments in the production of power, in refrigeration and in heating have not had time to lose their interest. In addition, a well-nigh universal misapprehension concerning the original discovery of the (basic) "Seebeck effect" were discussed.

22. ELECTRICAL CONDUCTION IN THIN MAGNETIC FILMS,

A. D. Campbell, J. F. Garren, Jr., A. C. Hudgins, Jr. and B. W. Sloope;
University of Richmond

Some aspects of the theory of electrical conductivity of thin films of metal are discussed. These are then applied to the case of thin magnetic films of Ni and Ni-Fe. Measurements of the electrical resistance were made on several films of different thicknesses with current applied in the direction of and perpendicular to the direction of the magnetization. The results of the measurements were discussed and compared with available theory.

23. SURFACE DEFORMATIONS ON SINGLE CRYSTALS OF COPPER AT VARIOUS TEMPERATURES.

John M. Bailey; *University of Virginia*

Surface deformation, which is important in the wear of metals as well as in many other metal surface phenomena, was studied by indenting various flat faces which had been carefully prepared on a single crystal of copper, and by scratching these faces at various directions. Styli with a wide range of radii were used, and normal and frictional

force on the stylus was measured. Experiments were conducted in air or in hydrogen at temperatures up to 800°C . The deformed regions were examined by optical and electron microscopes. Dislocation arrangements were studied by means of etch pits. The depth of plastic deformation was measured by means of electrolytic sectioning. Surfaces deformed at intermediate temperatures ($300\text{--}500^{\circ}\text{C}$, for a stylus with 794 micron radius, and 250°C to at least 800°C , for a stylus with 63 micron radius) recrystallized spontaneously. Deformation at higher temperature resulted in polygonization.

24. MOTIONS AND ABSOLUTE MAGNITUDES OF MIRA TYPE STARS.

H. L. Alden, V. Osvalds; *McCormick Observatory*
A Marguerite Risley; *Randolph-Macon Woman's College*

25. OSCILLATION THEOREMS FOR DIFFERENCE EQUATIONS.

John S. Plaskett; *University of Virginia*

Theorems analogous to those proved by Sturm for self adjoint differential equations are shown to hold for difference equations.

26. THE ELASTIC AND PLASTIC DEFORMATION OF VERY SMALL CADMIUM SINGLE CRYSTALS.

Thomas Ratchford; *University of Virginia*

Small cadmium single crystals, grown by deposition of the metal from the vapor phase in helium, were tested under applied pure tensions. These crystals had the shape of "ribbons," oriented such that basal slip could not occur. These ribbons had high yield stresses, and deformed by slip and twinning. The slip systems were the $(1212)/[1213]$ (pyramidal) system, and the $(0110)/[2110]$ (prismatic) system. Twinning seemed to be nucleated by the prismatic slip, the system by which fracture always occurred. Dislocation models are being developed to explain these phenomena.

27. CONDUCTIVITY OF METAL WHISKERS AT LOW TEMPERATURES.¹

E. P. Stillwell; *University of Virginia*

The electrical conductivity of copper whiskers grown from the hydrogen reduction of copper bromide and copper iodide has been studied as a function temperature from 273 degrees K. to 4.2 degrees K. Deviation from the bulk values are interpreted in terms of a contribution to the resistivity due to the inclusion of impurities in the crystal lattice plus a contribution to the low temperature resistivity due to the surface.

¹This work supported by the Office of Naval Research.

28. PIEZORESISTANCE EFFECT AT VERY HIGH ELASTIC STRAINS IN METALLIC WHISKERS.²

Herman H. Hobbs; *University of Virginia*

The effect of large elastic extensions on the resistivity of whiskers of Cu, Fe, Cd, and Zn has been studied. The maximum strains obtained were of the order of 0.02 thus extending considerably the range of

previous observations. The strain resistivity tensor $\left(\frac{\Delta P}{P}\right)_{ij} = K_{ijkl} \xi_{kl}$

for Cu whiskers grown from CuBr₂ has been determined. Results from copper whiskers grown from CuI and CuBr₂ indicate that inclusions of small amounts of Iodine or Bromine may have a strong effect on the strain-resistivity of copper. The strain-resistance curve for Zinc whiskers (oriented 30° from the C axis) is quite linear while the curve for Zinc ribbons (oriented parallel to the close packed plane) is strongly non linear.

29. POSITRON LIFETIMES IN WATER AND ICE.

W. W. Walker and W. S. Walker; *University of Virginia*

Positron lifetimes in water and ice have been measured as a function of temperature with particular emphasis on the water-ice phase change. Values of the mean life of the long-lived component (τ_2) for temperatures between -165° C and + 65° C will be given. A change in τ_2 at the phase transition has been observed. For water τ_2 has the approximately constant value of 1.5 ± 0.2 millimicroseconds and for ice τ_2 equals 0.8 ± 0.2 millimicroseconds. The intensity of the τ_2 component (I_2) has been observed to increase for the water-ice transition.

30. POSSIBLE EFFECTS OF FORCE FIELDS.

Leon Sembach; *University of Virginia*

We inquire into the possible effects of force fields upon radioactive decay rates. The apparatus used to measure decay rate of Cu⁶⁴ when subjected to 5.75×10^6 g's produced by an ultracentrifuge is described.

31. MECHANICAL PROPERTIES OF THIN POLYCRYSTALLINE METAL FILMS.

H. H. Pattillo; *University of Virginia*

The mechanical properties of thin evaporated polycrystalline films of gold and silver have been studied as a function of their thickness. Films less than approximately 1.5×10^{-5} cm in thickness show a marked increase in tensile strength, while films thicker than this have a tensile strength

² This work supported by the Office of Naval Research.

approximately equal to that of the bulk material. These values are in rough agreement with measurements by the centrifugal method on electrodeposited films. The increased tensile strength is believed due to actions of dislocations in the metals. Young's Modulus measurements in the elastic region give results apparently too high, and an explanation is being sought.

32. ELASTIC SCATTERING OF 2- TO 4-MEV POLARIZED NEUTRONS.

W. P. Bucher, W. B. Beverly, and G. C. Cobb; *University of Virginia*

The polarization of 2-Mev to 4-Mev neutrons elastically scattered by deuterium and carbon has been observed. The polarization produced in neutron-deuterium scattering was found to be negligible in agreement with theoretical estimates. The neutron-carbon polarization had the same energy dependence as predicted by phase shifts determined from differential cross section measurements of other workers. However, the magnitude of the polarization was larger.

33. RECENT HIGH PRESSURE INVESTIGATIONS OF SOLIDIFIED GASES AT LOW TEMPERATURE.¹

John W. Stewart and Robert F. Patterson; *University of Virginia*

The piston displacement technique has been applied to a study of phase transitions and compressibilities of solid CH_4 , CD_4 , and O_2 over the pressure range 0 – 19,000 kg/cm² and the temperature range 4°K – 120°K. The volume of the sample is observed as a function of pressure. Phase transitions appear as discontinuities in V (first order), or in dV/dP (second order). Solid CH_4 and CD_4 each show three phases and one triple point. The transitions appear to be second order with rather large "regions of indifference." There are considerable differences between the isotopes CH_4 and CD_4 . At atmospheric pressure CH_4 shows one transition at 20.5°K, while CD_4 has two, 22.1° and 27.2°. The two first order transitions in solid oxygen have been traced to high pressure. The upper transition has a very large volume discontinuity. Some difficulty was experienced from ignition of the steel pressure chambers by the solid oxygen under high pressure.

34. THE SURFACE STRUCTURE OF GROWING CRYSTALS.

N. Cabrera; *University of Virginia*

¹Supported by Office of Ordnance Research, U. S. Army.

BACTERIOLOGY

1. THE ENZYMATIC FORMATION OF D-ARABINOSE-5-PHOSPHATE

Wesley A. Volk; *University of Virginia*

D-Arabinose-5-phosphate has been isolated from mixtures of phosphorylated pentoses resulting from phosphorylation of L-arabinose or D-ribulose and ATP by crude extracts of *Propioni-bacterium pentosaceum*. An enzyme has been partially purified from these extracts which isomerizes both enzymatically formed and chemically synthesized D-arabinose-5-phosphate to a ketopentose phosphate presumably D-ribulose-5-phosphate.

The mechanism of formation of D-arabinose-5-phosphate will be discussed as well as some of the properties of the isomerase acting on D-arabinose-5-phosphate.

2. A COMPARATIVE STUDY OF MEDIA FOR THE DETECTION OF ENTEROCOCCI IN WATER.

R. Travis Hill; *State Department of Health Laboratory*

The fecal streptococci may prove of value as supplementary indicators of water pollution. Methods for their determination have not to date been included in Standard Method procedures, hence their evaluation by a committee. Two broth media for the tube dilution and one membrane filter medium were selected for comparative study in 8 different laboratories throughout the United States. Coliform densities were first obtained by the standard tube most probable number dilution method, in order that a relationship of the ratio of coliform to enterococci could be relatively determined.

3. SERUM LYSOZYME LEVELS IN RABBITS UNDERGOING A GENERALIZED GRANULOMATOUS REACTION.

Quentin N. Myrvik and Eva Soto Leake;

Department of Microbiology School of Medicine, University of Virginia

Rabbits vaccinated with BCG were given an intravenous infection of BCG four weeks after vaccination. A marked granulomatous reaction is elicited in the reticuloendothelial system. Soon after the intravenous infection of BCG the level of lysozyme increases markedly and after several days gradually returns to normal. The possible source of lysozyme will be discussed.

4. REDUCTION OF POTASSIUM TELLURITE BY *Streptococcus bovis*.
Margaret Carlson and P. Arne Hansen;

Department of Microbiology, University of Maryland

Reduction of potassium tellurite, useful as a tool for differentiation of fecal streptococci, was examined as a possible differential characteristic of *Streptococcus bovis*, a species which is not an "enterococcus." Test methods included incorporation of the potassium salt (concentration 0.04%) into both fluid and solid medium. Qualitative and quantitative determinations based upon growth in fluid medium appeared equivocal. Results obtained in solid medium were clear-cut and reproducible. All isolates were shown to be capable of reduction of potassium tellurite if tested under microaerophilic conditions.

5. OBSERVATIONS ON THE EFFECT OF CARBON DIOXIDE ON THE
GROWTH OF *Entamoeba histolytica*.

E. Clifford Nelson and Muriel M. Jones;

Department of Microbiology, Medical College of Virginia

A simple monophasic medium was found to support the growth of *Entamoeba histolytica* if the medium was saturated with and held in an atmosphere of carbon dioxide. A newly isolated strain was found to be more dependent on carbon dioxide addition than a strain grown for many years. The observations suggest that *E. histolytica* may have a carbon dioxide requirement.

BIOLOGY

1. EXPERIMENTAL EVOKATION OF DIFFERENTATION OF CHICK MELANOCYTES.

Williem M. Reams, Jr. and Stuart E. Nichols, Jr.;
Medical College of Virginia

This report deals with the capacity of certain chemical agents to evoke the branching of previously unbranched melanocytes within the peritoneum of Black Langshan chick embryos. Employment of small quantities of citric acid or of a CO₂ atmosphere in tissue cultures containing embryonic peritoneum laden with spherical melanocytes resulted in the branching of these cells. Citric acid injected *in ovo* produced precocious branching of the pigment cells in the vicinity of major blood vessels and dense capillary beds within the peritoneum. And, in most instances, resulted in an absence or reduction in the number of pigment cells within the peritoneum. (Supported by NIH Grant No. C-3450).

2. SEROSAL MELANOCYTES IN THE PET MOUSE.

Stuart E. Nichols, Jr. and Willie M. Reams, Jr.;
Medical College of Virginia

Save for the report of Burns that the processus vaginalis of the opossum is pigmented, mammals have been considered to lack pigment cells in the serosa of the body cavities. Recently, however, pigment cells have been found distributed in the serosa of a strain of mice, termed PET, maintained in this laboratory. The evidence available indicates that the three major pigmented areas (pleura, diaphragm and peritoneum) have their own respective sites of initial entry of melanoblasts from the neural crest. Experimentally, it has been shown that a melanoblast in the course of its differentiation into a definitive melanocyte passes through an intermediate stage of either a branched melanoblast or an unbranched melanocyte. The possible role of a chemical "effector" of pigment cell shape and its species specificity are discussed. (Supported by a grant from the Cancer Division of NIH.)

3. TECHNIQUES WITH A MICRORESPIROMETER.

Jack D. Burke, *University of Richmond*

A volumetric microrespirometer and a simplified shaking device is described. This apparatus is suitable for oxygen consumption analysis using different animals. The apparatus is also adequate for QO₂ experimental procedures as well as classroom demonstrations. Readings can

be made critically at the 0.01 ml. level of accuracy. Techniques and procedures for Q_{O_2} analyses are discussed in relation to data obtained using bullfrog tadpoles (*Rana catesbeiana*) and red-spotted newts (*Diemictylus viridescens*).

4. THE EFFECTS OF PROPYLTHIOURACIL OF GROSS WEIGHTS OF THYROID OVARIES, AND ADRENALS OF THE ALBINO RAT.

Iris B. Hadden and W. L. Mengebier; *Madison College*

A .05% propylthiouracil solution administered both orally and subcutaneously into the system of female Sherman albino rats produced the following organ weight increases: thyroid 170%, adrenals 30%, ovaries 165%. The total average body weight increase was 40%. Average daily body temperatures over experimental period were 1.18° lower than control animals, probably indicative of a lowered B.M.R. Weight increases of the adrenals and ovaries will be discussed relative to other publications.

5. TISSUE ERGOTHIONEINE.

Kamal Yackzan; *Florida State University* and *University of Richmond*

Ergothioneine's presence in animal tissues was first reported by Yackzan (M.S., 1951, Vanderbilt), using paper chromatography. The technique described by Lawson *et. al.* utilizes Hunter's diazo reaction and collodine-lutidine in the ration 3/2. A modification of this ratio plus the introduction of Baldrige and Lewis' solvent to the paper chromatograph's atmosphere increased specificity of the method. The interference of tyrosine and histidine was thus overcome. This technique represents a new approach in chromatography. Tissue extracts from the albino rat showed the presence of ergothioneine as follows: liver, 0.122 mg/gm; kidney, 0.083 mg/gm; heart, 0.03 mg/gm; spleen, 0.021 mg/gm.

6. A COMPARATIVE STUDY OF VERTEBRATE EMBRYONIC SERUM PROTEINS.

Edwin M. Weller; *Randolph-Macon Woman's College*

Electrophoretic analyses of embryonic bird and mammalian sera reveal several features of significance: 1. Embryo serum proteins partially resemble those of the adult and in addition have embryo-specific characteristics. 2. Bird and mammalian sera apparently show a common vertebrate electrophoretic pattern with superimposed class and species-specific features. 3. Serum in all vertebrate embryos (so far studied) develops epigenetically; a biochemical confirmation of morphological ontogenesis. Evidence for these summarizations was obtained by zone and free electrophoresis of chick, pheasant, duck, rat and rabbit embryonic and post-embryonic sera.

7. ACTION OF IPRONIAZID ON *Tetrahymena pyriformis*.Joseph Krezanoski; *Medical College of Virginia*

A diversity of pharmacological and biochemical effects have been observed with the drug iproniazid (Marsilid, Hoffman-La Roche Inc.). Among the outstanding effects are elevation of mood, stimulation of appetite, hypotensive effect, and the promotion of the healing process. The current concept of mono-amineoxidase inhibition by iproniazid does not adequately account for all these actions. In order to learn more about the mode of action of this drug its effects were examined on a protozoan, *Tetrahymena pyriformis*. Data on the effect of iproniazid on the rate of cell division, whole cell respiration as well as cell homogenate oxygen utilization will be presented. The report will include effects of various substrates such as acetate, tyramine, and glucose as well as certain co-factors such as nicotinamide and pyridoxine on iproniazid inhibition.

8. STUDIES ON THE CONTROL OF GROWTH IN TIMOTHY ROOTS.

Robert T. Brumfield;

Longwood College and Oak Ridge National Laboratory

The root cap and meristematic cells of the timothy root are covered by a gelatinous substance which inhibits the growth of elongating cells of a second root when transferred by contact. UV stimulates growth and the stimulation is transferred to nonirradiated roots. The substance is digested by RNase, its digestion being inhibited by IAA and stimulated by 2,4,6-trichlorophenoxyacetic acid. The latter compound inhibits UV stimulation and geotropism. Thus there is circumstantial evidence that the growth controlling substance is rich in RNA.

9. A COMPARISON OF INITIAL EFFECTS FROM GAMMA RADIATION UPON SOME GYMNOSPERMS AND ANGIOSPERMS.

W. S. Flory and W. Ralph Singleton;

The Blandy Experimental Farm, University of Virginia

In the early spring of 1958 several lots of nursery material were radiated in the Blandy Cobalt-60 radiation field. Fourteen conifers and 15 dicotyledonous angiosperms were included. Radiation dosages of 2500 r, 5000 r, 10,000 r and 20,000 r were used. The radiated conifers, practically without exception, either died within a few weeks or months after treatment, or else showed considerable injury from even the lowest dosage (2500 r) used. The several angiosperms, rather than being injured, often had a stimulation of growth following 2500 r or 5,000 r. With the angiosperms there was retardation of growth following 20,000 r, as well as dulling of foliage and considerable rosetting of terminal growth;

but practically all these plants from all dosages continued active throughout the 1958 season.

10. EMBRYOLOGICAL EVIDENCE FOR THE RELATIONSHIP OF AQUIFOLIACEAE TO CELASTRACEAE.

J. M. Herr, Jr.; *Pfeiffer College*

A comparison of the embryological features of the genus *Ilex*, the principle genus in Aquifoliaceae, with those reported for several genera in Celastraceae reveals several points of similarity. The most striking similarities involve the formation of the sporogenous tissue; the structure and growth pattern of the nucellus; the arrangement and behavior of the megaspores; and the development of the megagametophyte, especially the behavior of the synergids, polar nuclei, and antipodals. The preponderance of evidence indicates Aquifoliaceae to the more generalized status. However, in consideration of developmental features dissimilar in the two families direct derivation of Celastraceae from Aquifoliaceae is not tenable.

11. GROUND VEGETATION PATTERNS OF THE SPRUCE-FIR AREA OF THE GREAT SMOKY MOUNTAINS NATIONAL PARK.

Dorothy L. Crandall; *Randolph-Macon Woman's College*

Differences in undergrowth patterns form the basis for site types designated for the southern boreal forest. These eight site types, based upon frequency and coverage of species of shrubs and herbaceous plants, are as follows: (1) *Oxalis-Hylocomium*; (2) *Oxalis-Dryopteris*; (3) *Hylocomium-Vaccinium*; (4) *Viburnum-Vaccinium-Dryopteris*; (5) *Senecio*; (6) *Viburnum-Vaccinium-Senecio*; (7) *Viburnum-Vaccinium-Lycopodium*; (8) *Rhododendron*. Various interrelationships of the species of the lower and upper strata of these site types were discussed.

12. THE CONTROVERSIAL SEX-BIVALENT IN THE GOLDEN HAMSTER.

Lyman Randlett Emmons; *University of Virginia*

Koller (1938) reported both post-reductional (18.4%) and pre-reductional (81.6%) separation of the sex chromosomes in the Golden Hamster. Matthey (1951) re-examined the sex bivalent and found only pre-reductional separation of the X and Y. He stated that the conclusion of Koller was "une simple et ingenieuse vue de l'esprit." Matthey's work has cast doubt upon the coexistence of pre-reduction and post-reduction in the same species. Further study by this author substantiates Koller's original observation. A second type of post-reductional bivalent is described. Post-reduction occurs in our material in 10.9% of the cells rather than in 18.4%.

13. THE CHROMOSOMES OF ZEPHYRANTHES SPECIES FROM THE WEST INDIES.

W. S. Flory; *The Blandy Experimental Farm, University of Virginia*

Six *Zephyranthes* species are known from the West Indies. The present report describes the chromosomes of *Z. rosea* (24), *Z. puertoricensis* (25), *Z. insularum* (28), *Z. citrina* (48), *Z. carinata* (48) and *Z. bifolia* (60) (the somatic chromosome number appearing in brackets after each species). Chromosomes with median, near-median, submedian and sub-terminal centromeres occur in each species. The number of sub-median, or of submedian plus near median, chromosomes approximate either half or more than half the total number for each species. The number of long median pairs varies from one pair in *Z. rosea* to five pairs in *Z. bifolia*, with the number of sub-terminal ones being slightly higher. The total length in microns of all chromosomes varies from 122 in *Z. rosea* to about 250 in species with the higher numbers. Karyotype relationships have been studied, and will be discussed. (This study supported in part by NSF Grant G2716.)

14. A STUDY OF PHYLOGENY AND OF KARYOTYPE EVOLUTION IN LYCORIS.

Smritimoy Bose; *The Blandy Experimental Farm, University of Virginia*

Chromosome number and karyotype analyses have been made for 12 species and chromosome races in *Lycoris*. Somatic chromosome numbers involved here are - 12, 13, 14,15, 16, 17, 22, 27, 29+1B, 30 and 33. Karyotype analyses show five major types of chromosomes plus a very short euchromatic (B) chromosome. The basic number is suggested to be 6 or 11. Fusion and fragmentation of chromosomes, telocentric chromosomes, centromeric structure, in karyotype evolution and speciation, are recognized. Gene mutation, polyploidy and particularly hybridization, translocation and inversion are also considered in this connection.

15. EXPERIMENTAL INFECTIONS OF CHICK EMBRYOS WITH *Tetrahymena pyriformis*.

Jesse C. Thompson, Jr., Lynne Santy, and Valer Clark; *Hollins College*

Strain WH-1 of *Tetrahymena pyriformis* was inoculated into developing chick embryos at various stages of embryonic development (3rd, 5th, 7th, 9th, 11th, 13th, 15th, and 17th day of incubation) to determine the most susceptible stages for infection. Younger embryos were more susceptible but infections were established in all stages inoculated. Older embryos carried the infection through complete embryonic development and the yolk sac contained protozoa as long as 48 hours after hatching. Other embryos inoculated at 11th, 13th, 15th, and 17th day of incubation failed to show infections when examined 8 days after hatching.

16. PLANT MIGRATIONS IN MID-APPALACHIAN REGION.

E. L. Core, *West Virginia University**(An invitation address sponsored by the Committee on Virginia Flora)*

A large portion of the vascular flora indigenous to the middle Appalachian area has been here since late Mesozoic or early Cenozoic times. Some species in relict colonies may be remnants of a still older flora which has now mostly moved out onto the coastal plain. Boreal and sub-boreal species migrating southwards during glacial periods are now gradually withdrawing northwards along the mountain summits, while southern species are entering the area *via* river valleys penetrating the mountains. Prairie species from the mid-west are entering the artificial grasslands created through the removal of the forests.

17. VIRGINIA FLORA.

A. B. Massey, *Virginia Polytechnic Institute*

Field and herbarium work relating to the flora is progressing. Spare time and finances handicap those interested. The Committee on Virginia Flora sponsored the publication of the *Flora of Richmond*; for five years published *Claytonia*, a journal of Virginia botany. *Claytonia* was discontinued in favor of the *Virginia Journal of Science*. Sixteen individuals have each contributed 1 to 12 publications relative to the flora. Ten local or sectional herbaria have been developed. The Virginia Polytechnic Institute herbarium is state wide and is believed to be the largest herbarium in the state. Fernald, Allard, Hunnewell, and others have contributed many specimens to the Virginia Polytechnic Institute herbarium.

18. NOTES ON THE HELMINTHS OF MAMMALS IN THE MOUNTAIN LAKE REGION V. THE HELMINTHS OF RABBITS.

Harry L. Holloway; *Roanoke College*

The examination of ten rabbits (*Sylvilagus* species) during the summers of 1954 and 1956 disclosed the presence of five species of intestinal worms (one cestode and four nematodes) and one peritoneal cysticercus. Cestodes were: *Cittotaenia variabilis* and *Taenia pisiformis*. Nematodes were *Passalarus nonanulatus*, *Dermatoxys veliger*, *Trichostrongylus calcaratus*, and *Obeliscoides cuniculi*. The parasites appeared to have no effect upon the host and thus to be a real danger only during periods of undernourishment and old age when the energy requirements of the worm load become proportionately greater. Carl F. Clancey, et al (*Journal of Wildlife Management*, 1940) encountered four species of helminths in the examination of 342 rabbits in Connecticut. (Supported in part by awards from National Science Foundation and Mountain Lake Biological Station.)

19. EVALUATION OF RABBIT MANAGEMENT METHODS BY LIVE TRAPPING.

Donald K. Fortenbery; *Virginia Polytechnic Institute*

Rabbits were live trapped at Camp Pickett on three cultural type treatments in an effort to determine relative rabbit usage. Trapping was conducted in plots of winter grain-clover combination, rescue grass, annual mix of nine species and a control area. Forty-five days of trapping produced 135 individual cottontails of which 76 were recaptured. In the annual mix type, 40.75 per cent of the rabbits were captured; 34.10 per cent in the winter grain type; 11.85 per cent in rescue grass and 13.30 per cent in the control.

20. TECHNIQUES INVOLVED IN THE USE OF CHEMICALS FOR ESTABLISHING WILDLIFE CLEARINGS.

Harold A. Trumbo; *Virginia Polytechnic Institute*

Wildlife clearings have been established primarily by bulldozing and hand labor. These methods have been successful, but costly. Experiments indicated the feasibility of establishing wildlife clearings by the use of herbicides. A field experiment was initiated to make the following evaluations: (1) effectiveness of herbicides as tools, (2) cost comparison of herbicidal methods to others, and (3) utilization of these areas by game species. Four herbicides were used: Ammate, Monuron, Fenuron and 2,4,5-T. Monuron and Fenuron appear acceptable.

21. EFFECT OF FORESTRY PRACTICES AND WILDLIFE MANAGEMENT ON ABUNDANCE AND DISTRIBUTION OF DEER.

John H. Quillen, Jr.; *Virginia Polytechnic Institute*

A forested area of nearly 8,000 acres in Craig County has been set up for a 10 year study. Objectives are to study the effect of standard forestry practices and wildlife management techniques on the indigenous game species. This first phase of the project has been concerned primarily with abundance and distribution of deer. Data are being gathered through pellet group counts, track counts, trapping, direct observations and hunting season checks.

22. INCIDENCE AND CAUSES OF TULAREMIA IN HUMANS IN VIRGINIA.

Burd C. McGinnes; *Virginia Cooperative Wildlife Research Unit*

Virginia Department of Health reports of human tularemia cases were followed up by letters of inquiry to the respective county health authorities. Results of the three year study indicate the prevalence of the disease, distribution and major sources of infection.

23. THE EFFECT OF BLACKBIRDS UPON AGRICULTURE IN SOUTHWESTERN VIRGINIA.

Thomas C. Crebbs, Jr.; *Virginia Polytechnic Institute*

Investigations of reported damage to grain crops in Southeastern Virginia have proven that damage is almost directly proportional to weather conditions; and in the case of milo damage, to proximity of nesting colonies of Red-wing blackbirds. This season, damage to stacked peanuts by blackbirds was negligible. Though ignored by farmers, the monetary loss in field corn eaten by birds exceeded peanut losses. Grain sorghums were attacked only when adjacent to marshes, or by migrating Bobolinks.

24. A SURVEY OF THE FOOD HABITS OF *Rana catesbeiana* SHAW FROM FIVE DIFFERENT HABITATS.

Garnett R. Brooks, Jr.; *University of Richmond*

The food habits of 138 *R. catesbeiana* from five different types of ponds were studied. Habitats ranged from open pasture to dense woodland; intermediates were a composite of the two. With the exception of the food from the pasture pond, insects comprised the major food item by weight at all ponds (28-49 per cent). Although insects were numerous at the pasture pond, vertebrates constituted 64 per cent of the total food weight and insects only six per cent.

25. THE FOOD OF THE CHAIN PICKEREL, *Esox niger* LESUEUR IN TUCKAHOE CREEK, VIRGINIA.

David A. Flemer; *University of Richmond*

A survey was made from June through December, 1958, to determine the distribution and food habits of fishes in Tuckahoe Creek. Thirty one species, including 64 specimens of *Esox niger*, were collected. The pickerel, found only in the lower half of the creek, utilized insects, fishes, and crustaceans as food. Smaller specimens (less than 74 mm. in length) fed on insects 48 per cent of the time and fishes 30 per cent of the time. The diet of larger fish consisted primarily of fishes (63 per cent) and, to a lesser degree, insects (16 per cent). The data could not be treated statistically because of the lack of larger specimens.

26. RESPIRATION AND HEMOLYSIS OF ULTRAVIOLET IRRADIATED FROG ERYTHROCYTES.

Lewis Harvie and S. P. Maroney, Jr.; *University of Virginia*

Respiration and hemolysis of frog (*Rana pipiens*) erythrocytes suspended in phosphate buffered glucose-Ringer's solution were measured

following ultraviolet irradiation. Non-irradiated cells served as controls. Hemolysis increased with increasing radiation doses while at the doses used, oxygen consumption was not altered. These data are consistent with the concept that ultraviolet-induced hemolysis results from an alteration of the cell membrane rather than damage to the cell's source of metabolic energy.

27. OBSERVATIONS ON THE BIOLOGY OF *Pelomyxa palustris* GREEFF
COLLECTED UNDER POLYSAPROBIC CONDITIONS.

Daniel H. Stern; *University of Richmond*

P. palustris Greeff was collected in the Southampton Quarry near Richmond, Virginia. It appears to exist under polysaprobic conditions. The organism could be maintained for 8 months in the laboratory only in tightly capped containers filled with water from the habitat. Experiments seem to indicate that a microquantity of oxygen and a low temperature are important factors for successful cultivation. Culture of *P. palustris* according to methods previously reported in the literature was successful. Partial success was obtained when the organism was cultured using *Ankistrodesmus* sp. or organic debris from the quarry floor as food.

28. STUDIES ON TARDIGRADES FROM VIRGINIA.

G. T. Riggan, Jr.; *Virginia Polytechnic Institute*

Studies have been made on the tardigrade fauna of Southwestern Virginia, especially the regions surrounding Mountain Lake, Blacksburg and Mt. Rogers, Grayson County. A total of thirty species included in the genera *Echiniscus*, *Pseudoechiniscus*, *Macrobiotus*, *Hysibius*, *Diphascion*, *Itaquascon*, and *Milnesium* have been collected from moss, studied and identified. The report of these forms constitutes the first such citation from Virginia.

CHEMISTRY

BUSINESS SESSION

The possibility of having a short discussion period following each paper was considered. To allow time for this, it was suggested that two sessions might be held concurrently on Friday or a Saturday morning session might be added to the program. But no definite decisions were reached. The report of the nominating committee was presented, and the following officers were elected for the 1959-60 period by unanimous vote of the members present: *Chairman*, — Mearl A. Kise; *Secretary*, W. Allan Powell.

1. THE EFFECT OF FOREIGN METALS ON THE CORROSION OF TITANIUM IN BOILING 2M HYDROCHLORIC ACID.

W. Roger Buck, III, Billy Sloope and Henry Leidheiser, Jr.;
Virginia Institute for Scientific Research

The rate of corrosion of titanium was determined in boiling 2M HCl when contacted with aluminum, cadmium, tin, zirconium, lead, bismuth, mercury, silver, copper, antimony, vanadium, 70:30, 50:50 and 30:70 copper-nickel alloys, iron, palladium, cobalt, nickel, gold rhodium, platinum and iridium. Less extensive corrosion measurements of the same type were also made in 0.6 and 2M H₂SO₄. The potentials of the couple and of the two members of the couple were determined in boiling 2M HCl for 20 of the systems studied. A plot of the corrosion rate vs. the couple potential yielded a polarization curve which was similar to the anodic polarization curve for titanium with an impressed voltage. The curve exhibited a maximum in corrosion rate at a couple potential of -0.49 volt vs. the saturated calomel electrode. The potential of titanium in boiling 2M HCl was also determined as a function of concentration of the following metallic cations in the acid: copper, silver, antimony, nickel, gold, palladium, rhodium, platinum, and iridium. The influence of the cations on the corrosion rate was explained in relation to the polarization curve.

2. OXIDATIVE STUDIES OF DIPYRIDYLAMINES.

Robert N. Lawhorn, Ertle Thompson, Oscar Rodig and James W. Cole, Jr.;
University of Virginia

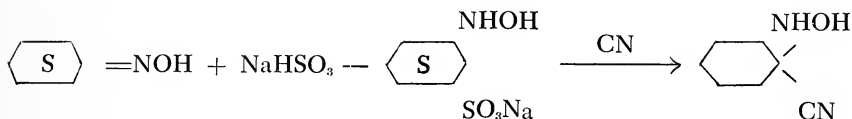
The dipyridylamines have shown interesting properties as high temperature antioxidants. Several new dipyridylamines were prepared by reacting substituted pyridylamines with their respective hydrochlorides.

In oxidation studies at 204°C., 2,2'-dipyridylamine and its symmetrical dimethyl derivatives were compared as antioxidants in di-(2-ethylhexyl) sebacate. The additive-di-ester solution was oxidized under controlled conditions and samples analyzed for peroxides and other property changes. The results were compared with each other and with those of similar runs with copper, in the elementary and combined form, also present in the system. There was distinct enhancement of the apparent antioxidant activity of the dipyridylamine when copper was present. Ultraviolet and infrared spectrophotometric studies as a means of determining the rate of disappearance of the additive and of identifying the oxidative products was discussed.

3. N-SUBSTITUTED α -AMINO NITRILES¹

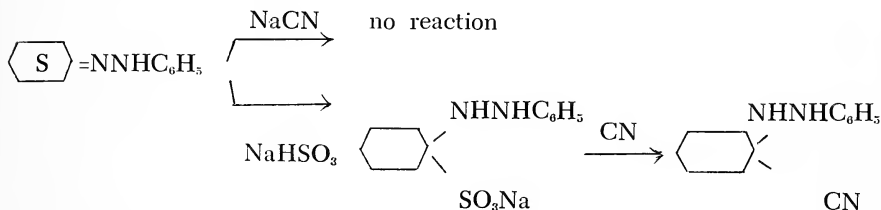
L. Neelakantan; *Medical College of Virginia*

Cyclohexanone oxime reacting with alkali cyanide in the presence of sodium bisulfite affords excellent yields of 1-hydroxylamino-1-cyano-cyclohexane. The reaction does not take place in the absence of bisulfite. The formation of α -amino nitriles from α -aminoalkansulfonates is known. Therefore, the following mechanism was proposed:



Similar results have been obtained with cyclopentanone oxime, aliphatic aldoximes and simple ketoximes.

The reaction can be extended to compounds such as phenylhydrazones and semicarbazones, e.g.,



4. QUANTITATIVE MICROANALYSIS OF ALOKOXY GROUPS.

Robert E. Bailey and Bryant Harrell;
College of William and Mary

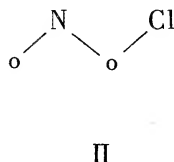
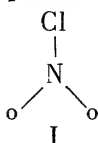
¹(Supported by NIH Grant CY 3024.)

The apparatus for the Zeisel determination of alkoxy groups has been simplified to consist mainly of six mm tubing jointed with standard taper joints. The reaction mixture is a mixture of phenol and concentrated hydrogen iodide, the wash solution saturated sodium carbonate and the receiver chamber is used for volatile compounds, which are weighed in sealed melting-point-type tubes. A precision of two or three parts per thousand was obtained with methoxy, ethoxy and propoxy.

5. A STUDY OF THE STRUCTURE OF NITRYL CHLORIDE.

John C. Kotz and Richard P. Carter; *Washington and Lee University*

An investigation was undertaken to confirm the structure of nitryl chloride through the use of its dipole moment. Two structures for the compound were postulated:



The microwave spectrum indicated the planar structure I, whereas, organic substitution reactions indicated either I or II with I being the more probable. The infrared spectrum, however, was ambiguous. By combining the above mentioned spectra with that of the visible and ultraviolet regions and using the dipole moment of the compound, structure I has been confirmed as the true structure of nitryl chloride.

6. SYNTHETIC HOMOLOGS OF α -AMINO ACIDS AND THEIR DERIVATIVES AS ANTI-TUMOR AGENTS.

John Andrako, J. Doyle Smith and W. H. Hartung;
Medical College of Virginia

A number of substituted acetamidomalonic esters, *dl*- α -acetamido acids and *dl*- α -amino acids were prepared and submitted for testing in the screening program of the Cancer Chemotherapy National Service Center. The substituted acetamidomalonic esters were synthesized by conventional alkylation of diethyl acetamidomalonnate with alkyl and aralkyl halides. Saponification of the substituted esters gave the *dl*- α -acetamido acids. Acid hydrolysis of the esters was employed to obtain the *dl*- α -amino acids. The available results of screening tests performed on these compounds in the tumor systems employed by the Cancer Chemotherapy National Service Center were reported. (Supported by the Department of Health, Education and Welfare Contract No. SA-43-ph-1807.)

7. SELECTED ADDITION COMPLEXES OF NITRIL CHLORIDE.

Richard P. Carter and John C. Kotz; *Washington and Lee University*

Using nitril chloride as the primary reactant and metal halides and interhalogen compounds as secondary reactants, various addition complexes of the general nature of nitronium fluoborate, $\text{NO}_2(\text{BF}_4)$, were obtained. Some physical properties and constants of these compounds, as well as reactions with organic compounds, were investigated. These reactions were carried out to determine more conclusively the mechanism of aromatic nitration, as well as the value of these addition complexes as nitrating agents.

8. THE INFRARED ABSORPTION OF PHOSPHORUS COMPOUNDS.

Margaret Anne Barber; *Virginia-Carolina Chemical Corporation*

A correlation has been made of the infrared absorption of organic and inorganic phosphorus compounds with their chemical structures. Results from a number of sources have been collected and compared. Typical literature values have been compared with actual absorption spectra obtained on the Perkin-Elmer "Spectracord" (one of the recently developed "low cost" infrared spectrometers). Charts have been prepared of the characteristic absorption of atomic groupings most frequently encountered in phosphorus compounds. Practical applications of these data have been made in utilizing infrared absorption to follow the oxidation of a P(III) compound to a P(V) compound and to analyze mixtures of the allotropes of sodium triphosphate.

9. SPECIFIC CENTERS IN PALLADIUM CATALYSTS.

Robert L. Beamer and Walter H. Hartung;
Medical College of Virginia

Two thoughts suggest that catalysts prepared by depositing palladium on a suitable carrier may have highly specific centers. First, it has been observed from previous work that the qualitative properties, e.g., the rate at which a given substrate is hydrogenated are appreciably influenced by the method of preparation of the catalyst. Second, from analogy with biocatalysis or enzyme reactions and assuming random deposition of the metal, it is postulated that only those centers onto which a substrate molecule "fits" may act catalytically. A design of experiments and apparatus to test these hypotheses was presented and supporting data were discussed.

10. RESEARCH IN CANCER CHEMOTHERAPY.

John E. Yurko and Bryant Harrell; *College of William and Mary*

The National Program of Cancer Chemotherapy along with some of its purposes was briefly explained. The most widely used present-day methods of cancer control were mentioned and the most promising types of cancer chemotherapeutic drugs were listed along with the type of action exhibited. The syntheses of some methane sulfonates and similar compounds were undertaken in the laboratory. The compounds were submitted to the Cancer Chemotherapy National Service Center for screening.

11. RECENT ELECTRON AND OPTICAL MICROGRAPHS OF A CATALYST SURFACE.

Allan T. Gwathmey and Shaukat Azim; *University of Virginia*

Past studies with single crystals of copper have shown that certain faces only are stable during the catalytic reaction of hydrogen and oxygen. Preliminary studies with the electron microscope revealed many interesting types of surface structures not previously observable with the optical microscope. More recent studies with the electron microscope have been made of the catalyst surface under different conditions of experimentation. The influence of imperfections and long periods of time on surface structures was more carefully investigated and were described with the aid of micrographs.

12. ELECTRON MICROSCOPE OBSERVATIONS ON THE DECOMPOSITION OF MOLYBDENUM TRIOXIDE AND CUPROUS OXIDE.

Kenneth R. Lawless; *University of Virginia*

When some materials are observed in the electron microscope with a high intensity beam, changes may take place in the specimen. Molybdenum trioxide single crystals exhibit several changes due to the heating up of the strained specimens in the vacuum. The changes observed were: 1) sublimation, 2) recrystallization, 3) apparent precipitation of a new phase along specific crystal planes and 4) complete conversion to MoO_3 . Thin films of cuprous oxide under some conditions also decompose, forming copper nuclei which continue to grow as the specimen is heated by the electron beam. These changes may be followed both by electron microscopy and electron diffraction.

13. CAROTENOID PIGMENTS OF AGED BURLEY TOBACCO.

H. E. Wright, Jr., W. W. Burton and R. C. Berry, Jr.;
The American Tobacco Company

The carotenoids of aged Burley tobacco were separated by column chromatography. Eighteen pigment bands were observed in an amount corresponding to 43.3 $\mu\text{g./g.}$ of dry leaf, less than 25% of the carotenoid

content of green Burley tobacco. One of the major carotenoids, Pigment X, apparently was a nonether *cis* polyol adsorbing above zeaxanthin. α -Carotene, β -carotene, cryptoxanthin, lutein, zeaxanthin and Pigment X, including respective stereoisomers, comprised 98% of the carotenoids. Minor constituents included five pigments whose partial identification indicated that they may be: a monohydroxy- α -carotene, an epiphasic lutein isomer, β -carotenone aldehyde and two *cis*-lycopenes. Violaxanthin and neoxanthin, major xanthophylls of fresh, green tobacco, were not found in the aged tobacco.

14. QUALITATIVE ELEMENTARY ANALYSIS OF ORGANIC COMPOUNDS BY A COMBUSTION METHOD.

Frank Denaro and Bryant Harrell; *College of William and Mary*

Organic materials were converted into soluble combustion products which were then analyzed for chlorine, bromine, iodine, sulfur, nitrogen, carbon and hydrogen by usual qualitative methods. The combustion proceeds at high temperatures in an atmosphere of oxygen and the combustion products were absorbed in a solution of sodium hydroxide.

15. A STUDY OF THE ACID CATALYZED CLEAVAGE OF 10-CYCLOHEXYL-1,2-BENZANTHRACENE.

F. A. Vingiello and T. Delia; *Virginia Polytechnic Institute*

In connection with the extensive studies conducted on aromatic cyclodehydration, it became clear that certain *meso* substituted 1,2-benzanthracenes are subject to acid cleavage. The synthesis and cleavage of 10-cyclohexyl-1,2-benzanthracene was reported. The synthesis of several new ketones and the cleavage of several other *meso* substituted 1,2-benzanthracenes was discussed.

16. SURFACE TENSION, INTERMOLECULAR DISTANCE AND ASSOCIATION ENERGY OF A PURE NON-POLAR LIQUID.

Ralph G. Steinhardt, Jr.; *Hollins College*

It is known that a linear relation exists between molecular refraction and the parachor of pure liquids. A simple mathematical development of this relation leads to the conclusion that, for pure non-polar liquids, the decrease in surface tension with increasing temperature can be attributed solely to the corresponding increase in intermolecular distance. It can also be shown that a simple approximate relationship exists between surface tension and the London energy. Therefore, for a pure non-polar liquid, the surface tension is a simple, approximate function of the total intermolecular association energy.

17. SOME COLORLESS POLYENES OF AGED BURLEY TOBACCO.

H. E. Wright, Jr., W. W. Burton and R. C. Berry, Jr.;
The American Tobacco Company.

Several colorless polyenes of aged Burley tobacco were separated by column chromatography. Neophytadiene, phytoene and phytofluene were identified. In addition, two colorless polyenes were found whose partial identification indicated that they may be isodesmethyloxerophthene and α -ionone. Neophytadiene was the principal colorless polyene identified.

18. PROOF OF STRUCTURE OF 4-HYDROXY-2-METHYLTETRAHYDROTHIOPHENE 1,1-DIOXIDE.

Robert C. Krug and James A. Rigney, *Virginia Polytechnic Institute*

In the presence of a strong base, 2-methyl-2,5-dihydrothiophene 1,1-dioxide and 2-methyl-2,3-dihydrothiophene 1,1-dioxide (I) were converted to a mixture of an alcohol (II) and 2-methyl-4,5-dihydrothiophene 1,1-dioxide. Since I was obtained from the pyrolysis of the acetate from II, the new alcohol was assigned the structure 4-hydroxy-2-methyltetrahydrothiophene 1,1-dioxide. To confirm the assignment, an independent synthesis was undertaken which established the structure of II as proposed. The eight step synthesis proceeded through a cyclic ketosulfide which had been prepared by Larsson (Svenk. Kem. Tid., 57, 248 (1946), to a dinitrobenzoate which was identical with the same derivative prepared from II.

19. INHIBITION OF THE NITROSTYRENE CONDENSATION IN ACETIC ACID BY TRACES OF WATER.

Charles E. Bell, Jr., and Thomas I. Crowell;
University of Virginia

The formation of the nitrostyrene from nitromethane and piperonal, in the presence of n-butylamine, was followed gravimetrically in glacial acetic acid. The rate decreased very markedly with increasing water concentration in the range 0.03 to 2% water. Equilibrium measurements showed a corresponding decrease in the concentration of the intermediate Schiff base, partially accounting for the observed inhibition.

20. QUANTITATIVE SEPARATION OF SOME PYRIDINE COMPOUNDS BY PAPER CHROMATOGRAPHY.

Eugene Glock and T. H. Vaughan, Jr.;
The American Tobacco Company

A paper chromatographic procedure was developed for the separa-

tion and quantitative determination of nicotine, pyridine, β -picoline and several other pyridine derivatives which may be found in cigarette smoke. The pyridine compounds were separated in bands as their hydrochlorides by one-dimensional descending paper chromatography employing a n-butanol-HCl-H₂O as the developing solvent. The pyridine compounds were located on the chromatograms in microgram quantities by their absorption of short-wave ultraviolet light and their characteristic fluorescence and phosphorescence in liquid nitrogen. The separated chromatographic bands of the pyridines were eluted with HCl and the amounts were determined by ultraviolet spectrophotometry. This method has been applied to the determination of several pyridine compounds in cigarette smoke.

21. THE PREPARATION OF A 10-(HYDROXYMETHYLPHENYL)-1,2-BENZANTHRACENE.

F. A. Vingiello and C. Lewis; *Virginia Polytechnic Institute*

Recently, 10-phenyl-1,2-benzanthracene was prepared. The compound was tested for carcinolytic activity by the National Institute of Health. It showed slight anti-tumor activity when tested against several tumors. In view of this information, it obviously became interesting to try to prepare a 10-hydroxymethylphenyl-1,2-benzanthracene and to test its physiological activity. The synthesis of this compound was reported upon.

22. KINETICS IN A DUAL TEMPERATURE SYSTEM.

Thomas I. Crowell; *University of Virginia*

A chemical equilibrium having forward rate constants k_1 and k_1' and reverse rate constants k_2 and k_2' at temperatures T and T' will reach a steady state if the temperature fluctuates rapidly between these two temperatures. The steady-state concentrations are given by an apparent equilibrium constant, $K_o = (k_2' + nk_2)/(k_1' + nk_1)$ where the system remains n times as long at the lower temperature as at the higher. Experimental data and possible applications were given, including evaluation of the activation energy from K_o and n .

23. AN INVESTIGATION OF THREE DERIVATIVES OF CHROMOTROPIC ACID AS POSSIBLE COLORIMETRIC REAGENTS FOR THE SIMULTANEOUS DETERMINATION OF URANIUM AND THORIUM.

H. Perry Holcomb and John H. Yoe; *University of Virginia*

A method for the spectrophotometric determination of uranium using 3-(2-arsenophenylazo)-4,5-dihydroxy-2,7-naphthalene-disulfonic acid (trisodium salt) has already been developed. This reagent and two other derivatives of chromotropic acid, 4,5-dihydroxy-3-(p-sulfophenylazo)-2,7-

naphthalenedisulfonic acid (trisodium salt) and 4,5-dihydroxy-3-(p-nitrophenylazo)-2,7-naphthalenedisulfonic acid (disodium salt), are being examined as possible colorimetric reagents for the simultaneous determination of uranium and thorium. Spectral studies of these compounds and of their uranium and thorium complexes were presented.

24. COLOR REACTIONS OF 1,4-DIHYDROXYANTHRAQUINONES.

E. Guy Owens, II; *University of Virginia*

1,4-Dihydroxyanthraquinones from intensely colored complexes with a variety of metallic ions. Color reactions of a series of substituted 1,4-dihydroxyanthraquinones with beryllium and aluminum were studied with regard to analytical applications.

25. SPECTROPHOTOMETRIC DETERMINATION OF MANGANESE (II).

Dwight O. Miller; *University of Virginia*

The concentration of manganese in human plasma and red cells is extremely low, so low that a more sensitive procedure than the permanganate colorimetric method is needed. Manganese (II) reacts with diethyldithiocarbamate to yield a colored complex which has been used for the spectrophotometric determination of the metal. Diethyldithiocarbamate and other substituted dithiocarbamates were studied as reagents for the spectrophotometric determination of manganese (II) and the extractabilities of the manganese complexes with various organic solvents were investigated.

26. SPECTROCHEMICAL DETERMINATION OF TRACE AMOUNTS OF NICKEL IN NORMAL HUMAN PLASMA AND RED BLOOD CELLS.

Leonel M. Paixo; *University of Virginia*

A spectrochemical method for the simultaneous determination of magnesium, chromium, nickel, copper and zinc in human plasma and red blood cells was developed in the Pratt Trace Analysis Laboratory. The limit for nickel was 0.02 p.p.m. and in some samples, nickel was not detected. Because so little is known about the nickel content of human blood fractions, an effort was made to increase the sensitivity of the method. The details of the studies were reported upon.

27. SOME OBSERVATIONS OF CRYSTAL IMPERFECTIONS DURING OXIDATION AND CATALYTIC REACTION ON COPPER.

R. H. Kean; *University of Virginia*

The locations of imperfections or discontinuities in the atomic lattice of crystal surfaces, whether caused by atomic dislocation, by edges or

corners of atomic planes or by impurities, all represent points of abnormal surface energy. As such, their role in the mechanism of chemical reactions occurring on solid surfaces is of considerable theoretical interest. Thus, the identification of these points on crystal surfaces and their correlation with points of preferential chemical activity, as in the first stages of oxidation of a metal, or in the dissolving of metal by etching or in the catalytic activity of the surface, have recently been increasingly the objects of experiment. The results of a few preliminary experiments in this field were presented.

EDUCATION

1. THE RELATION BETWEEN ACE SCORES AND ACADEMIC SUCCESS IN COLLEGE.

Alfred L. Wingo; *State Department of Education*

Essentially a progress report since the study had not been completed.

2. SOME SOCIO-PSYCHOLOGICAL FACTORS AFFECTING THE DEVELOPMENT OF CHILDREN'S INTERESTS.

Judy Hollen and G. W. Kent; *Bridgewater College*

The purpose of this study was to examine a number of factors which are generally viewed as important in the formation and change of children's interests. These factors were age, grade, school, sex, and interest area. The California Pictorial Interest Inventory was administered to approximately 500 children in grades 4 through 7 enrolled in five elementary schools in Rockingham County, Virginia. Only sex and interest area were found to differ significantly. It was concluded that the large differences observed in sex and interest area, and the lack of significant differences in age, grade, and school is a function of the test employed to study interest. This test is designed as a vocational guidance tool rather than as an instrument for studying children's interests.

3. A STUDY OF TEACHER EVALUATION TECHNIQUES.

Donald Banks and G. W. Kent; *Bridgewater College*.

Eight faculty members at Bridgewater College participated in an evaluation study in which three different rating scales were employed together with two methods of ranking. Students rated these teachers using the rating scales. A selected group of student leaders also evaluated the teachers by means of the paired comparison and rank order tech-

niques. The teachers themselves used these two ranking techniques, and the college President and Dean likewise ranked the teachers via these two techniques. The faculty members were found least consistent in their rankings, while the administrative officers were the most consistent. The correlations among the various methods were in excess of .90, all were significant at the .001 level of confidence. Three hypotheses were advanced for these data: (1) The high correlations result from a confounding of judgements about teaching skill with personal liking for the teacher. (2) The period of time a teacher has been on the faculty will influence his rank (the first year teacher as opposed to the older teacher). (3) The basis for ranking the teachers was prestige and reputation rather than personal experience. Since all methods yielded similar results, it is concluded that the method to be employed is a function of other considerations than reliability and validity of measurement.

4. BACKGROUND OF COLLEGE TEACHERS.

W. D. Clague; *Bridgewater College*

The data for this report were collected by the use of questionnaires returned by a random sample of the teachers of the accredited four-year colleges of the south. This report is part of a larger study entitled "Sources of Teaching Personnel for Church Related Colleges of the South." College teachers in general come from the middle or lower educational and social groups of our society. They come from homes in which the parents have achieved a formal education below graduation from high school. More college teachers come from rural farm homes than from any other single occupational group. Business, skilled and unskilled labor, and the professions other than the ministry and teaching are the occupations next in order. Less than ten percent of college teachers come from homes in which the parents were teachers at any level and very few come from the homes of college teachers. The decision to enter college teaching as a career was generally made comparatively late in the college teacher's educational program. Less than one-half of those who eventually became college teachers had decided to do so by the time of graduation from college. Even so the most important factor in the choice of college teaching as a career was encouragement by one's college teachers to enter college teaching by the individual himself. It seems safe to conclude that college teachers come from a level of society in which college teaching is viewed as an opportunity to improve one's self and as a result of personal contacts between college teachers and their students.

5. RECONSTRUCTING THE CURRICULUM OF MAHACHULALONGKORN RAJAVIDYALAYA BUDDIST UNIVERSITY UNDER ROYAL PATRONAGE AT BANGKOK, THAILAND.

Kurt F. Leidecker; *Mary Washington College*

Two Buddhist universities serve the Thai clergy who cannot attend the secular colleges and universities, one being Mahamakuta Rajavidyalaya controlled by the Dhammayukta Sect of Hinayana Buddhism with approximately 18,000 monks and novices and favored by the aristocracy, the other Mahachulalongkorn Rajavidyalaya, controlled by the Mahanikaya with approximately 222,000 members. It was the latter which asked the writer to serve as Foreign Adviser during 1956 and 1957 while he did a tour of duty as Cultural Affairs Consultant with the U. S. Information Service and Embassy at Bangkok. In numerous conferences with the Rector and staff a streamlined curriculum and an administrative organization were evolved basically along American lines, incorporating the desiderata and omitting certain subjects not applicable to members of the monastic order, yet stressing others not previously incorporated into the curriculum.

The fully worked-out curriculum is an integrated one emphasizing the humanities and Asian studies. It is so constructed that gradually more phases of it can be activated when and if the extremely modest funds and limited facilities are increased and instructors become available. It was anticipated that aid could be obtained from various sources. This hope, has, in part, been materialized. A large classroom building is now being completed; more instructors have made themselves available on a gratuitous basis; a modest system of publications has been initiated; and the holdings of the library which was organized on the Dewey Decimal System have been materially increased. Administration and the younger members of the Buddhist Ecclesiastical Order especially are eager for a fuller and better education and are aware of the necessity of the knowledge of English. Foundational and other support would be welcome and go a long way toward increasing the educational facilities of an influential yet educationwise somewhat neglected sector of the Trai population.

6. Symposium: RELATIVE MERITS OF LABORATORY VS. DEMONSTRATION
IN THE TEACHING OF SCIENCE.

A. L. Wingo; Moderator

Earl Savage; *Richmond Public Schools*

Sydney S. Negus; *Medical College of Virginia*

Franklin D. Kizer; *State Department of Education*

Richard Irby; *Department of Research and Development,
American Tobacco Company*

Lindele A. Pitt; *Richmond Public Schools*

ENGINEERING

1. THE MEASUREMENT OF GAS ION CURRENTS.

Robert L. Ramey and Robert L. Overstreet; *University of Virginia*

The use of a pair of electrometer tetrodes in a balanced amplifier permits measuring currents down to 6×10^{-18} amperes, considerably smaller than the minimum grid currents of the tubes. The control grid of each electrometer tube is permitted to float, each grid circuit being completed via the effective leakage resistance R_1 and R_2 of the corresponding tube. The grid to ground capacitance C_1 and C_2 of each tube is adjusted so that $R_1 C_1 = R_2 C_2$ and the accelerating grid of each electrometer tube is adjusted to balance the quiescent plate currents of the tubes. Any signal current is applied to the control grid of No. 1 tube is given by

$$i_s = \frac{S C_1}{g_{m_1}} \frac{R_{c_1} (1 - R_{eq_1}/r_{p_1}) + R_{c_2} (1 - R_{eq_2}/r_{p_2})}{R_{eq_1}} \frac{dx}{dt}$$

where S is the deflection sensitivity of a galvanometer connected directly between the anodes of the two electrometers, $\frac{dx}{dt}$ is the observed deflection rate of this galvanometer, and g_{m_1} is the transconductance.

R_c is the anode coupling resistor, r_p the dynamic plate resistance, and

$$R_{eq} = \frac{r_p R_c}{r_p + R_c} \text{ of each tube. The time available for linear}$$

measurements is $T = 0.2 R_1 C_1$

For new electrometer tubes the effective grid leakage R_1 runs about 5×10^{15} ohms and a typical value for C_1 is 4 mmfd., yielding a measurement time of 4,000 seconds.

2. RESEARCH IN CONTINUOUSLY REINFORCED CONCRETE PAVEMENTS.

Howard Newlon; *Virginia Council of Highway Investigation and Research*

In currently designed concrete pavements, provision must be made to accommodate movements caused by changes in atmospheric conditions. Transverse joints are included so that relatively low tensile strength

of the concrete is not exceeded. In recent years interest has been revived in a design method whereby transverse joints are eliminated. Because of the absence of joints, cracks form as the pavement contracts but if sufficient reinforcing steel is included the cracks will be held tightly closed and will not constitute a structural weakness. Thus far the approach to this new design has been experimental in nature but certain factors, i.e. thickness, amount of steel, and general behavior, have been tentatively established.

In order to understand more clearly the fundamental behavior of this type of pavement, the Virginia Department of Highways plans an experimental pavement on Route 95 near Emporia. As a part of this project, theoretical studies have been made by Dr. William Zuk and a model pavement constructed in the form of a sidewalk. This paper presented (1) some basic facts concerning the design of continuously reinforced and conventional pavements; (2) a brief summary of information obtained from past research; and (3) plans for future research in Virginia.

3. THEORETICAL ANALYSIS OF TORSION IN SKEWED BRIDGES.

William Zuk; *University of Virginia*

To meet the requirements of modern highway transportation, bridges are often built with the abutments skewed to the longitudinal direction of the roadway. Among the previously unsolved problems of this type of bridge is the problem of the torsional effects that exist in the main stringer beams of such bridges, particularly ones built with the beams integral with the bridge decks. Theoretical solutions for the torsion in the beams of uniformly loaded bridges are found for two conditions of end bearing orientation. The first condition of bearing orientation is the standard one in which the bearings are parallel to the direction of the abutments. Solutions are obtained by considering the bridge system as an orthotropic plate, with the governing orthotropic differential plate equations transformed into skewed coordinates to more easily satisfy the boundary conditions. When the free spans of the decks are not greater than the widths of the roadways, the solutions of the deflected surfaces of the bridges are considerably simplified. From the equations of the deflection surfaces, torsion formulae for the stringer beams are thus obtained.

4. THE EFFECT OF MECHANICAL VIBRATION ON LIQUID FILM HEAT TRANSFER COEFFICIENTS.

Dennis M. Frame; *University of Virginia*

The theory that vibration should increase heat transfer between flowing liquid systems is based on the fact that vibration should destroy or reduce the laminar film at the pipe wall. The work described consis-

ted of designing a counter-current concentric tube heat exchanger in which the inner tube could be vibrated in a direction parallel with the directions of flow. Tests were run with both frequency and amplitude varying and with amplitude varying while frequency was held constant. The range of flow rates investigated covered values of Reynolds numbers from 2,000 to 22,000. The data obtained indicate that there is a small increase in heat transfer coefficients with the vibration when the Reynolds numbers are in the range of 6,000 to 14,000. This increase appears to be at most only around four percent of the original coefficient value. The data indicate a very small effect of amplitude and indicate that frequency is the variable effecting the changes in the film coefficient. The results of this work indicate that vibration would be impractical for exchangers operating at Reynolds number above 2,000.

5. ENERGY AMPLIFICATION IN A TWO-COMPONENT NOZZLE FLOW.

John E. Scott, Jr.; *University of Virginia*

Energy amplification of a supersonic molecular beam source is given theoretical consideration. A two-component jet composed of a light carrier gas which is "seeded" with a heavy gas serving as the active component is employed. The concept is that the heavy molecules will have their energy augmented by collisions with the lighter ones during the expansion process. The analysis shows that the energy augmentation, expressed in terms of an energy amplification factor, can become quite large for the case of large differences in mass of the active component and carrier gas. The fraction of the total energy available which appears as kinetic energy of the heavy component is close to unity for large mass ratios even though only a small quantity of heavy gas is used. Introduction of a velocity lag parameter shows that even a small lag in velocity between the heavy and light molecular components results in a marked decrease in energy augmentation. However, it is concluded that energy amplification factors of significance can be obtained using the "seeding technique" which will enable the extension of the range of aerodynamic molecular beam source experiments.

6. THE STATIC AND DYNAMIC STABILITY OF SEVERAL BODY SHAPES IN NEWTONIAN FLOW.

E. Brian Pritchard; *Virginia Polytechnic Institute*

It is the purpose of this paper to investigate several missile nose configurations to determine the most efficient body from the standpoint of stability. Three configurations were chosen to be studied. These are: (1) a hemisphere; (2) the cone inscribed in the hemisphere; (3) the minimum-drag cone frustum for the same fineness ratio as the hemisphere. For each of the above bodies, Newton's impact theory was ap-

plied to define its static and dynamic stability. In this investigation, three physical mass distributions were chosen for each body type; namely, (1) a solid, homogeneous body; (2) a shell body without a base; (3) a shell body with a closed base. In order to investigate the static and dynamic stability it was necessary to define the stability derivatives C_{N_a} , C_{N_q} , C_{M_a} , and C_{M_q} . Having defined these parameters the

stability of each missile nose configuration was obtained for each physical mass distribution.

7. THE APPLICABILITY OF SANDWICH CONSTRUCTION TO MISSILE SHAPES.

Joseph S. Pratt and E. Brian Pritchard; *Virginia Polytechnic Institute*

The applicability of sandwich construction for missile shapes is investigated from an applied load consideration. A general missile configuration, consisting of a cone with a cylindrical afterbody is considered. Honeycomb and corrugated core types of sandwich construction are used in the analysis of the cone and cylindrical afterbody. The buckling loads are established and the results compared for both core types. It was found that the structure displayed a large margin of safety for both core types under the loading encountered at an altitude of 100,000 feet and a Mach number of 10 for the given diameter of the missile. It was concluded that, from a strength to weight ratio consideration, the aluminum honeycomb core sandwich construction is more efficient than the corrugated core type.

8. ON THE OPTIMIZATION OF TRAJECTORIES.

Robert B. Richards and James B. Eades, Jr.; *Virginia Polytechnic Institute*

A method is presented for the optimization of the trajectory and the mass distribution of a vertical sounding rocket. In general the optimal path will be composed of path segments flown with maximum thrust, variable thrust and in coasting flight. As a consequence of the optimization the composition of the complete extremal path is defined. The problem presented is that of determining the optimum path for maximum altitude with a two-stage rocket vehicle. This problem is solved with the assumption of an isothermal atmosphere and a constant drag coefficient corresponding to supersonic flight. For the complete optimization of both the trajectory and the mass distributions, the problem is necessarily solved by a double iteration procedure. A sample problem was presented to show the procedure for calculation, and to illustrate the influence of staging on the solution.

9. ON THE PROBLEM OF EARTH SATELLITES.

Roland N. Bell and James B. Eades, Jr.; *Virginia Polytechnic Institute*

This paper is a presentation of a highly refined method for approximating the trajectory of a satellite-carrying vehicle. Refinement is attained by the treatment of thrust, drag and gravity as variables and the division of the flight into several phases. By making only the most essential simplifying assumptions, integrable relations for terms describing the characteristics of the trajectory are obtained. The integration and application of these relations has been limited to small intervals so as to keep the incurred error negligible and, hence, the solutions are obtained by a stepwise integration process. A brief analysis of the elements of the elliptic orbit completes the derivation. To employ and test the equations obtained, a sample problem was worked based on a three-stage vehicle similar to the Vanguard. The results obtained from the solution of the sample problem are presented in tables and graphs.

10. LAMINAR BOUNDARY LAYER CONTROL BY MAGNETOGASDYNAMIC TECHNIQUES.

Charlie M. Jackson, Jr., and Robert W. Truitt;
Virginia Polytechnic Institute

In this paper a method of analyzing the two dimensional high-speed laminar boundary layer with an applied transverse magnetic field is presented. A closed-form solution is obtained for the governing equation of the compressible boundary layer over a body with pressure gradient. An analysis is made to determine a method of maintaining a constant boundary layer thickness over an arbitrary body by magnetogasdynamic techniques. It is found that by controlling the applied magnetic field strength the boundary layer can be maintained constant. Using the governing equation of the boundary layer, an expression is developed for the necessary variation of the magnetic field strength. The problem of maintaining a constant boundary-layer thickness over a hemicylindrical leading edge of a wing is considered. The solution, that is — the necessary variation of the magnetic field strength — is presented for a constant electrical conductivity and for the more realistic condition of a variable electrical conductivity. An analysis is made of the variation with temperature and density of the electrical conductivity of ionized air. Closed form expressions are obtained for the viscous and magnetic drag coefficients of the hemicylinder with constant boundary-layer thickness.

11. COMPRESSIBILITY EFFECTS IN MAGNETOGASDYNAMIC FLOW.

Linwood B. Callis and Robert W. Truitt; *Virginia Polytechnic Institute*

The subject of this paper is the determination of the effects of

shock-interaction of the laminar boundary-layer characteristics under the influence of an applied magnetic field. In order to determine expressions for the magnetogasdynamic boundary-layer characteristics, the general van Karman integral momentum equation is used with the addition of a magnetic body force term. From a consideration of this equation and other basic relations, expressions for the skin friction, boundary-layer thickness, and boundary-layer temperature were obtained. Having these expressions, relations were then obtained giving the ratios of pressure, velocity, temperature, density, and viscosity as functions of a shock-interaction parameter; the ratios being that of a quantity in a region where no interaction is present. In order to determine the effects of shock-interaction on the boundary-layer characteristics, similar ratios of these characteristics were taken. Introducing the shock-wave boundary-layer interaction parameter, by means of the basic ratios previously mentioned, the effects of shock-interaction on the boundary-layer characteristics may be determined. The results, and the implications of these results, are given at the end of the paper.

12. THE FUNDAMENTALS OF THE SEPARATION OF HYDROGEN AND CARBON DIOXIDE BY GASEOUS DIFFUSION.

Russell A. Primrose; *Virginia Polytechnic Institute*

The diffusion was studied of carbon dioxide and hydrogen in equal proportions through barrier materials of fiber glass filter media at flow rates of 2, 4, and 10 cubic feet/hour and pressures of 2.5 and 10 psia. An 0.008-inch Dexitel filter manufactured by Dexter and Sons gave 0.5% separation, while one 0.015-inch thick Vetra filter manufactured by Mine Safety Appliances gave 3%. A sintered stainless steel screen gave 3 to 4% with a pressure drop of 1.5 inches of water. Other filter media are being investigated.

13. THE DESIGN, CONSTRUCTION, AND OPERATION OF A HEAT EXCHANGER FOR A MOVING BED HYPERSORPTION PROCESS.

William A. Barkley and Stuart B. Row; *Virginia Polytechnic Institute*

Efficient heat exchange in the desorption heat exchanger of a moving bed hypersorption column has been difficult to obtain with standard heat exchangers. To evaluate the heat transfer characteristics of the activated carbon absorbent, a one-tube, vertical-tube heat exchanger was built. This heat exchanger had a length of three feet, a tube diameter of $\frac{7}{8}$ inches, and a shell diameter of $2\frac{1}{2}$ inches. The activated carbon flow rate was varied from 1.6 to 2.4 pounds per hour, and the steam pressure was varied from nine to 70 psig. The exchanger was also evaluated with and without agitation. From these experimental data, heat transfer coefficients, the maximum temperature of absorbent, and the optimum

operating conditions were obtained. Using the results obtained from the one-tube heat exchanger, a heat exchanger was designed and constructed for use in an experimental hypersorber. By evaluation of the variation of the steam pressure, agitation, and carbon flow rate, the optimum operating conditions of the heat exchanger were determined.

14. FUNDAMENTAL FACTORS AFFECTING MASS TRANSFER IN A MIXER-SETTLER TYPE EXTRACTION.

N. C. M. Landis, G. E. Brown and F. W. Bull;
Virginia Polytechnic Institute

A three stage mixer-settler liquid-liquid extraction unit arranged for countercurrent flow has been built for extractions using the system tolueneacetone-water. Each stage is composed of two sections of 2-inch diameter glass-pipe, 6 inches high, separated by an aluminum block. The two phases enter a stage through a copper tube nozzle in the aluminum block. intimate mixing occurs and centrifugal motion is imparted to the liquids. After mixing in the nozzle the two phases are allowed to settle by gravity and centrifugal action, and the light and heavy phases from each stage are removed from top and bottom of the stage. Two different nozzles ($\frac{1}{4}$ and $\frac{3}{8}$ inch) were used for rates of 120 and 200 pounds per hour total flow. Mass transfer coefficients and stage efficiencies have been calculated for the extraction of acetone from toluene with water using one, two, and three stages and both large and small nozzles; and for the extraction of acetone from water with toluene using one stage and a small nozzle. The necessary solvent to feed ratio for optimum transfer and stage efficiency has been determined.

15. THE EXTRACTION OF SODIUM HYDROXIDE AND ACETIC ACID FROM A SEMI-CHEMICAL PAPER PULP WASTE USING ELECTRODIALYSIS.

Nelson F. Murphy and Earl J. Holberg; *Virginia Polytechnic Institute*

The feasibility of electrolytically extracting sodium hydroxide and acetic acid from semi-chemical pulp black liquor using ion membranes was studied in a three-compartment cell having a steel cathode and platinum anode. Waste feed, dilute sodium hydroxide, and dilute acetic acid were introduced to the bottom of the central, cathode, and anode compartments respectively. Sodium ions passed into the cathode compartment through a 5-inch diameter Amberplex C-1 cation permeable membrane and acetate ions passed into the anode compartment through an Amberplex A-1 anion permeable membrane. Five tests conducted at about 360 ml. per hour anolyte feed rate and 60 ml. per hour catholyte rate were carried out in one to six hour periods with current varying from 0.772 to 1.00 amperes giving diaphragm current densities from 0.039 to 0.050 amperes per sq. in. The cathode diaphragm efficiency

rose from 18.3% to 89.5% for a six hour test, while the corresponding anode diaphragm efficiency rose from 5.5% to 40.8%. The cell took more time with each test for the current to reach one ampere at 32 volts. The weight of the products extracted per kilowatt-hour of power increased with the length of the test.

BUSINESS MEETING.

The business meeting of the section was called by the chairman at 4:00 p.m. on Friday, May 8. The nominating committee, N. F. Murphy, R. M. Hubbard and D. M. Crim, chairman proposed a slate of officers for the next year. Unanimously elected were O. R. Singleton, Jr., Chairman, Stuart B. Row, Secretary, and R. M. Hubbard, Editor. Four selected contestants from the Junior Academy of Science described their exhibits and answered questions of members. Mr. Eugene MacFarlane of Marian High School, Marian, Virginia was selected to receive the George Washington Engineering Award for 1959. The business meeting then adjourned.

16. GENERAL DESCRIPTION OF THE UNIVERSITY OF VIRGINIA NUCLEAR REACTOR.

Lawrence R. Quarles; *University of Virginia*

The University of Virginia has under construction a one megawatt swimming pool reactor which is scheduled to go critical next spring. The reactor facility is located near the western limits of the University and is readily accessible to all interested science departments. It will be operated by the School of Engineering but is designed for research use by the science departments and the Schools of Medicine and Engineering as well as for instruction in nuclear engineering. The divided pool offers a high degree of flexibility in use. The reactor may be positioned in either section of the pool for operation at approximately 100 kilowatts with convection cooling. Provision is made for forced cooling for operation at one megawatt with the reactor positioned at one end of the pool. Built-in facilities include two 8" beam holes, a 4' x 6' access port and a thermal column. A large research area is provided at the top of the pool and another adjacent to the access ports. Plans call for eventual provision of radiation chemistry and hot laboratory facilities.

17. INHERENT SAFETY OF THE SWIMMING POOL TYPE NUCLEAR REACTOR.

J. L. Meem; *University of Virginia*

The key to the inherent safety of the swimming pool type reactor is in the use of ordinary water as a coolant and moderator. Neutrons produced by fission are high energy neutrons and must be slowed down to thermal energies before initiating additional fissions in the reactor. This process of slowing down neutrons is called moderation, and water is an

excellent moderator. If for some unknown reason, there is a sudden increase in power, the water is heated and becomes less dense, and this decreases the ability to slow down neutrons. Accordingly, the fission rate and reactor power decrease. This characteristic is called the "Negative Temperature Coefficient." All swimming pool type reactors have negative temperature coefficients and are inherently self stabilizing. An even more important characteristic of this type reactor is the "Negative Void Coefficient." An accident has never occurred in a swimming pool type reactor which initiated a power surge sufficient to cause boiling, but assuming such an accident did occur, it is easy to see that if sufficient heat were produced to cause boiling, the steam voids produced would greatly decrease the water density and shut down the reactor at once.

18. HAZARDS ANALYSIS FOR THE UNIVERSITY OF VIRGINIA NUCLEAR REACTOR.

Walter P. Walker; *University of Virginia*

This paper summarizes an evaluation of hazards which could result from an accident in a swimming pool-type research reactor. Each way in which radioactive contamination could be released and dispersed is considered, and for each an estimate is made of the radiation level to which off-site personnel might be exposed. Both probable and improbable (but conceivable) events are illustrated by numerical calculations for the University of Virginia reactor.

19. SHIELDING OF THE UNIVERSITY OF VIRGINIA NUCLEAR REACTOR.

W. Reed Johnson; *University of Virginia*

Shielding a nuclear reactor infers the protection of personnel and equipment from the effects of direct radiation from the reactor itself and its auxiliary systems. Although the University's swimming pool reactor is a comparatively simple type, it poses shielding problems analogous to those found in much more elaborate reactor plant designs. Gamma rays and fast neutrons are the important types of radiation the shield designer must consider. The first task is to specify the sources of radioactivity. These sources are, in general, the reactor itself, and the reactor cooling system. The latter is caused by neutron activation of the water coolant as it flows through the reactor core. Methods of calculation used in the shield design are those developed primarily by workers in the nuclear submarine field. The results of the shield calculation shows that the pool itself serves as a good shield for radiation from the reactor, while additional shielding in some areas is required to reduce the radiation from the coolant system.

20. HEAT TRANSFER IN THE UNIVERSITY OF VIRGINIA NUCLEAR REACTOR.

F. Anthony Iachetta; *University of Virginia*

This paper describes the core configuration of the University of Virginia Nuclear Reactor with relation to heat transfer to the coolant water. The core consists of twelve full fuel elements and four control rod elements arranged in a 4 x 4 matrix reflected by two outer rows of graphite elements. The coolant flow rate must be great enough to prevent local boiling at the hottest fuel element. Power density was assumed to vary as a sine function from zero at the core boundary to a maximum at the center 2.6 times the average. The heat transfer calculations were based on an inlet water temperature of 95°F. with the reactor producing an average power of 1 megawatt. The equations needed to predict bulk fluid temperature and fuel plate surface temperature were developed in terms of the appropriate physical properties of the system. The heat transfer coefficient for the fluid film was determined using Colburns equation for flow inside tubes. For various coolant flow rates, the maximum fuel plate surface temperatures were calculated and from these results, a pump capacity of 1,000 gpm was found to be satisfactory.

21. STUDY OF THE FISSION PRODUCT ACTIVITY IN THE GAS STREAM OF A GAS COOLED NUCLEAR REACTOR.

David D. Wallace; *University of Virginia*

This paper is a study of the activity of fission products entrained in the coolant stream of a helium cooled, high temperature reactor system using unclad fuel elements. The specific design examined is the Sanderson and Porter pebble bed reactor. The study is principally concerned with the effect of various purification rates on entrained and deposited fission product activity in the primary coolant system of this reactor type, and is purely theoretical. The fuel is assumed to be U-235. Those decay chains involving fission products which are volatile at core temperatures are examined, and the activity contribution of each such fission product is calculated, as is that of solid and liquid daughter isotopes which may be deposited in the system. These calculations are made for purification probabilities of 0,0,000,001, 0.000,01, 0.000,1, 0.001, 0.01 and 0.1.

22. AN ANALOG FOR THE STUDY OF TEMPERATURE CONTROL IN JACKETED CHEMICAL REACTION VESSELS.

William B. Cashion; *University of Virginia*

The thermal resistances of the various heat transfer surfaces in a jacketed chemical reaction vessel play an important part in automatic temperature control. The effect of each resistance on controllability should

be known before reactor design is begun if satisfactory temperature control is to be obtained. A direct electrical analog can stimulate a reaction vessel quite well and can be used to study the effect of each thermal resistance on automatic control. Pneumatic control instruments can be used with the analog to eliminate the need of an operational analog computer which would be required to simulate them. The electrical resistance — capacitance network for simulating a reaction vessel was described along with the control system. Cascade control was selected because of its industrial popularity on this type application. The analog compares satisfactorily with experimental data on a 50 gallon reactor.

23. HEAT TRANSFER IN A HOT WATER STORAGE HEATER.

Robert M. Hubbard and Edward J. Leech; *University of Virginia*

Overall heat transfer coefficients were measured on a standard 475 gallon steam heated hot water storage heater. Steam pressure was 20 psi gauge, water flow rates were 267, 307, 338 and 398 gal. per hour, and water pressure was varied from 5 to 60 psi gauge at each flow rate. With the highest water pressure, outlet water temperature varied from 193 to 218°F and at the lowest pressure it varied from 185 to 215°F. Overall heat transfer coefficients having maximum values from 190 to 210 Btu per hr per sq ft per °F decreased by 10 to 15% with increased water pressure. The higher heat transfer coefficients observed with low water pressure on the outside of the heating surface was explained by incipient boiling and greater water turbulence. The lower coefficients at higher water pressure were explained by the decreased turbulence in the water resulting from convection heat transfer with little or no bubble formation.

24. FACTORS INFLUENCING THE VOLUMETRIC HEAT TRANSFER COEFFICIENT IN A PARALLEL-FLOW SPRAY DRIER.

Everett L. Plyler; *University of Virginia*

A seven cubic foot spray drier was employed to assess experimentally the influence of drier operating variables on the volumetric heat transfer coefficient. Atomization of the feed was accomplished by a two-fluid nozzle, and drying gases were introduced cocurrently with the spray. Aqueous sodium sulfate solutions were used for the investigation of feed rate, temperature level of drying gases, and average mass flow of gases. The influence of the nature of the material dried was studied using powdered milk suspensions, sodium chloride, and sodium sulfate solutions. A linear relation correlated satisfactorily the effect of feed rate on the volumetric heat transfer coefficient in the range 1.2 to 3.8 gal/hr. The volumetric heat transfer coefficient decreased as the average mass flow rate of drying gases was increased from 480 to 820 lbs./hr. A decrease

in this quantity also resulted as the inlet gas temperature was raised from 380 to 480°F. The results of three runs in which a powdered milk suspension, a sodium chloride, and a sodium sulfate solution were dried under similar operating conditions indicated little difference in the heat transfer coefficients for these materials.

25. SOLUBILITY AND LIQUID DENSITY OF CARBON DIOXIDE IN METHYLENE CHLORIDE AT 70° F. AT PRESSURES UP TO 300 PSIG.

Donald S. Buell and John W. Eldridge; *University of Virginia*

The methylene chloride — carbon dioxide system is of interest in the Aerosol Industry as a propellant mixture. This study was undertaken to extend the available liquid density and solubility data. Methylene chloride was degassed by distillation and transferred to an equilibrium cell under vacuum. Carbon dioxide was then charged under pressure. The cell was rocked in a constant temperature bath. Pressure readings were usually constant after fifteen minutes, and equilibrium was assumed after one hour. The equilibrium cell was designed so that a liquid sample could be isolated in a calibrated volume, disconnected, and weighed while under pressure to determine liquid densities. The sample was then analyzed by passing the vaporized liquid phase sample through a series of sodium hydroxide solutions to extract the carbon dioxide. The solutions were then titrated with standardized hydrochloric acid. Liquid density values ranged non-linearly between 1.322 gms./cm.³ at zero psig. and 1.222 gms./cm.³ at 300 psig. Agreement with the literature value of 1.324 gms./cm.³ at zero psig was good. Solubility values indicated a nearly linear relationship between zero and 300 psig. The carbon dioxide content was found to be 30.0 mole percent at 300 psig.

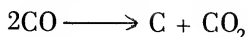
26. CATALYTIC STUDIES ON SURFACES OF SINGLE CRYSTALS OF NICKEL-COPPER ALLOYS.

Edwin Cox, Otis L. Updike, and Allan T. Gwathmey;

University of Virginia

An atom of nickel has two electrons in its 4s subshell but only eight 3d electrons. This gives nickel a pronounced "3d character." Copper has only one 4s electron but all ten 3d electrons, and therefore has no 3d character. Dowden and others have established a possible relation between 3d character and catalytic activity. Though copper and nickel have nearly the same atomic radius and alloy to form a simple solid solution in all proportions, investigators have reported a sharp change of physical and chemical properties in the region of 60-70 percent copper, where increasing copper content should cause a loss of 3d character. Effects of composition on catalytic activity are being investigated with single crystals of Cu-Ni alloys to study the relation of these effects to 3d

character. The reaction employed is:



Catalytic activity is observed both by rate of formation of carbon and by rearrangement of the surface as viewed under the optical and the electron microscopes. Experimental problems have included irregular crystal growth and difficult surface preparation. Electron micrographs of the surfaces after reaction show unusual carbon patterns, but as yet no crystals as high as 60% Cu have been available.

GEOLOGY

BUSINESS MEETING

A total of over seventy-five attended the sessions of the Geology Section. A brief business meeting followed the discussion of the last paper. Upon the recommendation of the nominating committee the following officers were elected:

Chairman — J. L. Calver; *Vice-Chairman* — E. W. Ramsey; *Secretary* — R. S. Mitchell; *Section Editor* — B. W. Nelson; *Historian* — J. K. Roberts.

FIELD TRIP ..

The annual field trip, under the leadership of G. H. Espenshade and E. O. Gooch, took place Saturday, May 9. The major stops of this trip included a soapstone quarry and plant at Schuyler; the Arvon-Buckingham Slate Company operation at Arvon; and the Kyanite Mining Corporation mine at Willis Mountain. About twenty-five took part in the trip.

1. THE GROUND-WATER RESOURCES OF WESTERN ALBEMARLE COUNTY, VIRGINIA.

Whitman Cross, II; *University of Virginia*

This study is concerned with the factors affecting the yield of drilled wells in the western half of Albemarle County, Virginia. The relative importance of lithology, structure, residuum, and topography was analyzed from data collected on 300 well sites. The effect of topography was found to be the greatest single influence on well yields. This same conclusion was recently reached by studies in similar Piedmont areas of

Georgia, North Carolina, and Maryland. Because of more intense fracturing and a greater recharge area, the valleys and draws provide a larger yield per well than other topographic locations. Hills provide the lowest yield with 20 percent of the wells considered dry. Yields vary from less than 1 gpm to over 75 gpm, but average between 5 and 15 gpm. Well depths range from 60 feet to over 700 feet, but average between 100 and 150 feet. The depth of residuum is occasionally as great as 100 feet, but averages about 50 feet. A large majority of the wells receive water from fractures less than 100 feet deep. Well-logging with resistivity, self-potential, and gamma ray probes was carried out to determine if water-bearing fractures, indicated by well cuttings and drillers' logs, could be located with these geophysical methods. Although an insufficient number of wells have been logged to date, a definite relationship appears to exist between log curves and the reported fracture zones. Several localities within this area show excessive iron varying from 1-10 ppm. This excessive iron content may be attributed to associated basic rocks. Acidity, ranging from pH 6.0 - 7.0, is common.

2. GARNET DEPOSITS IN THE VIRGINIA PIEDMONT.

Claude W. Crist, Jr.; *University of Virginia*

The Virginia Piedmont is composed of igneous, sedimentary, and metamorphic rocks. The metamorphic rocks are the result of regional metamorphism and often contain garnet. The writer has collected samples from outcrops containing garnet at various points over the Piedmont. These samples were studied under the polarizing microscope in the geology laboratories at the University of Virginia. This study brought out the following facts: (1) Garnet formed during regional metamorphism of pelitic sediments of the Virginia Piedmont is found only in Precambrian rocks; (2) Only one locality in Virginia contains unusually large garnets; (3) The amphibole, cummingtonite, was found to occur with garnet at several localities. Cummingtonite has not been reported in Virginia before; (4) Crystal forms in pegmatites are usually tetragonal trisoctahedrons while those in metamorphic rocks are dodecahedrons. Garnet was found to occur in the following rock types: Schist, quartzite, gneiss, phyllite, and granite. The minerals which occur most frequently with garnet in these rocks are: Quartz, magnetite, limonite, biosite, muscovite, chlorite, zircon, sericite, plagioclase (albite), graphite, cummingtonite, staurolite, kyanite (?), apatite, and epidote. Several new garnet localities were found during this study. Two unsuccessful attempts have been made to mine garnet in Virginia in the past.

3. A DISCUSSION OF IRON OXIDE PSEUDOMORPHS AFTER PYRITE METACRYSTS IN THE PIEDMONT SCHISTS OF VIRGINIA.

Robert K. Peare; *University of Virginia*

This paper is concerned with the petrology and mineralogy of pseudomorphs of iron oxide after pyrite metacrysts from the Lynchburg formation of Virginia. The area from which the pseudomorphs were collected is approximately 120 miles long, extending from Jeffersonton in Culpeper County, southwestward to the Roanoke River between Bedford and Franklin counties. Over four thousand pseudomorphs were collected from 23 localities. About 13% of the specimens were found to be magnetic and displayed magnetic polarity. Two hundred specimens were studied in polished section and the mineral constituents were checked by x-ray diffraction. Pyrite, goethite, hematite, and magnetite were found, as well as minor amounts of quartz and sericite. Pyrite, containing incorporated sericite and euhedral magnetite, was the original mineral. Goethite replaces the pyrite, and hematite along with finely disseminated magnetite replace the goethite. Hematite is never found in direct contact with the pyrite. The replacement has taken place along the [001] and occasionally along the [111] cleavage directions of the original pyrite. Textural features indicate that the replacement occurred under supergene conditions.

4. THE GEOLOGY OF THE PIEDMONT PHYSIOGRAPHIC PROVINCES OF VIRGINIA AS APPLIED TO HIGHWAY ENGINEERING.

W. T. Parrott; *Virginia Department of Highways*

The geology of the Piedmont of Virginia lends itself to a series of paradoxes insofar as highway engineering is concerned. From a wealth of aggregate for highway uses in the Triassic areas of the northern part, it passes into famine conditions in the southern part; its soil varies from loamy soil of the south to the extremely plastic clays of the north. Injurious minerals render some types of aggregate unfit for highway uses, while others form so strong an acid in the streams that only concrete structures will resist its corrosive action. The general geology of the Piedmont was discussed as well as some of the problems of highway engineering and construction.

5. HIGHWAY ENGINEERING IN VIRGINIA PHOTOGRAMMETRIC METHODS.

F. B. Bales; *Virginia Department of Highways*

The engineering and construction of the Interstate Highway System is advancing in Virginia through the use of Aerial Photography and Photogrammetry. Through photo interpretation and topographic mapping by aerial methods, the Engineer is able to select a highway location from the standpoint of soil, geology, drainage, and excavation; thus avoiding areas containing unsuitable materials, sinkholes, potential slide or mass movement areas, areas subject to frost heaving, caving, areas subject to flooding, areas of erosion and at the same time providing a facility which

will best serve the traffic demand. An Aerial Survey Section adequately staffed and completely equipped, including a complete Photographic Laboratory, has been established within the Virginia Department of Highways for the purpose of meeting the aerial photography and photogrammetric mapping requirements of the Department.

6. SOME METAMORPHIC FEATURES OF THE PRECAMBRIAN ROCKS OF THE SOUTHERN BLACK HILLS, SOUTH DAKOTA.

J. A. Redden; *Virginia Polytechnic Institute*

The metamorphic rocks of the southern Black Hills are largely medium-to high-grade schists containing some units of quartzite, meta-iron formation, and other rock types. There are few differences in the mineral assemblages of most of the rock units above and below the sillimanite isograd. Sillimanite appears first in moderately aluminous quartzose beds and is not found in some highly aluminous rocks, apparently because a high content of ferromagnesian constituents in the latter tended to tie up the aluminum in garnet, staurolite, and cordierite, and, delay or prohibit the appearance of sillimanite. The area has experienced at least two peaks of metamorphism. An early episode of regional metamorphism has been modified by later more nearly thermal metamorphism. The latter is apparently associated with the emplacement of considerable granite and pegmatite. The outer limit of the pegmatite distribution coincides locally with the sillimanite isograd.

7. THE DORE LAKE COMPLEX: A METAMORPHOSED LAYERED COMPLEX (CHIBOUGAMAU DISTRICT, QUEBEC.)

Gilles O. Allard; *University of Virginia*

The Dore Lake Complex is a stratiform sheet similar to the Bushveld, Stillwater, and Duluth Complexes, but differs from those by the predominance of anorthosite and anorthositic gabbro and also by the regional metamorphism (greenschist facies) which has produced some unique and rare rock types. The Dore Lake Complex is located in the Chibougamau mining district, Province of Quebec, Canada, 320 miles north of Montreal. It introduces Keewatin-type volcanic rocks and originally had a flat sill-like shape but has been arched by a younger granitic batholith. The layered complex is 27 miles long and approximately 10,000 feet thick. Anorthosite and gabbroic anorthosite formed the main layer of the mass. It is now metaanorthosite, a mixture of albite, zoisite and/or clinozoisite, and chlorite. Small patches of unmetamorphosed anorthosite indicate a very calcic plagioclase (An80). The metaanorthosite grades into a transition zone (gabbroic metaanorthosite and anorthositic metagabbro) which is overlain by magnetite-rich metapyroxenite, metapyroxenite, serpentinized dunite and/or serpentinized peridotite. This in turn is inter-

banded and overlain by metagabbro, different types of diorites, and granophyre. Layering, foliation, and banding is present throughout but difficult to observe in the very coarse anorthosite layer. The area is transected by 3 sets of fractures. The southeast-trending shears are commonly mineralized and copper ore is mined or explored along 9 of those zones. All the orebodies located so far are in the anorthosite-gabbroic anorthosite member of the Dore Lake Complex.

8. PRELIMINARY REPORT ON THE GEOLOGIC INVESTIGATION OF THE ROSELAND ANORTHOSITE AND ASSOCIATED TITANIUM DEPOSITS.

Neil Hillhouse; *Virginia Polytechnic Institute*

The Roseland anorthosite body, an intrusive mass composed chiefly of oligoclase with some andesine, underlies an area of approximately 25 square miles in Amherst and Nelson Counties, Virginia. It is intrusive into the Lovingsston gneiss, a complex of meta-igneous rocks, now chiefly biotite-feldspar augen gneiss of quartz-monzonitic composition with a few inclusions of meta-sedimentary rocks and some fine-grained schists. The contact between the massive anorthosite and the gneiss is gradational over most of the region. In many places, the "border facies" consists of contaminated anorthosite producing a highly feldspathic gneiss. Much of the border region is marked by small, possibly later, intrusions of granite-textured rocks ranging in composition from diorite to granodiorite. Titanium deposits in the form of ilmenite-apatite bodies (nelsonite dikes) are localized near the anorthosite-gneiss contact. Titanium also occurs as rutile in the anorthosite, as ilmenite disseminated in the gneiss and granitic rocks, and as ilmenite in magnetite bodies in the gneiss. The iron to titanium ratio increases, therefore, with distance from the center of the anorthosite, indicating that introduction of Titanium accompanied intrusion and that the iron in the ilmenite deposits was supplied by the country rocks. It is believed, however that the upper and outer parts of the anorthosite mass had solidified and been sheared before mineralization by titanium-bearing, fluorine-rich fluids from the core of the mass.

9. MINERAL INDICATORS OF ENVIRONMENT IN SEDIMENTS OF PART OF THE MARYLAND COASTAL PLAIN.

Dorothy Carroll; *U. S. Geological Survey*

The basal beds of Early Cretaceous age (Potomac group) consists of gravels, sands, and clays derived from the weathering of Piedmont rocks. These materials were deposited in swamps and lakes. The clays carried iron oxides that in the reducing environment of the swamps and lakes. The clays carried iron oxides that in the reducing environment of the swamps provided the iron for the crystallization of pyrite and siderite. The presence of these minerals indicates the redox potential of the deposition basins. Kaolinite is the principal clay mineral. Mixtures of kaolinite

and water (1 to 5) have pH values of 5 to 6 which suggests a low pH during and after deposition. The detrital heavy minerals include angular and corroded staurolite, garnet, and tourmaline. Both staurolite and garnet have crystal structures in which ferrous iron can be attacked by solutions. The corrosion of these minerals is thought to be due to the low pH and Eh conditions of the environment, and is an expression of the diagenetic changes in the minerals. Acid clay in this environment is an active chemical weathering agent and detrital minerals in contact with it are corroded. The low Eh helps to keep any iron removed in solution.

10. MONOCRYSTALLINE SPELEOTHEMS.

James F. Quinlan, Jr.; *Virginia Polytechnic Institute*

The following observations have been made: 1) Monocrystalline speleothems consist of calcite. 2) All the cleavage planes of a monocrystalline speleothem are those of a typical calcite rhomb whose optical c-axis coincides with the long axis (axis of growth) of the speleothem. 3) The tip of most monocrystalline speleothems is triangular. 4) Externally monocrystalline speleothems may have 3, 4, 5, 6, 8, or 12 sides, not all of which are necessarily equally developed. 5) Some monocrystalline speleothems consist of a monocrystalline core that is covered by a sheath of either radially deposited calcite or concentricly deposited calcite, clay, and perhaps aragonite. In some specimens this is due to precipitation within the central tube. In a few other specimens it appears that there never was a central tube as such. 6) The central tube of some externally monocrystalline stalactites has a rhombic cross-section rather than a typical round cross-section. 7) Some apparently monocrystalline stalagmites exhibit a radically mozaic texture in thin section. 8) Some stalactites have been found to consist of a twinned calcite crystal. 9) Some monocrystalline stalactites cleave in a plane which has six small saddles that occur at the periphery of the stalactite and give it a stellate appearance. In thin section these saddle-shapped areas are characterized by off center optic axis figures. The conditions that determine the occurrence of monocrystalline speleothems instead of the development of the more typical forms are not known. Probably the development of monocrystalline speleothems is directly influenced by: 1) presence or lack of chemical impurities, 2) lack of contaminating clay, 3) drip rate of calcium bicarbonate solution, 4) rate of precipitation, 5) temperature.

11. THE AGE AND THE FAUNA OF THE HUNTERSVILLE FORMATION.

Philip S. Ciaramella, Jr.; *Virginia Polytechnic Institute*

Several good Huntersville-Tannersville area, Tazewell county, exposures are located on the southeast limb of a large plunging anticline that has been dissected by erosion. The formation, consisting of chert, sand-

stone, and limestone, is approximately 120 feet thick. An unusual well preserved fauna contains corals, crinoids, bryozoans, brachiopods, pelecypods, and ostracodes. Among these there are several new species and one genus of brachiopod. Most of the identifications are restricted to the generic level. Several of the specific identifications made relate species to those found in the Devonian of New York. On the basis of the brachiopods the formation is upper Oriskany, Esopus, Schoharie, and Onondaga in age. The occurrence of the brachiopod *Spirifer macrus* Hall suggests that beds of the same age as the Moorehouse member of the Onondaga are present. The youngest member of the Onondaga, the Seneca, may or may not be represented.

12. CELESTITE AND STRONTIANITE FROM WISE COUNTY, VIRGINIA.

R. F. Pharr and R. S. Mitchell; *University of Virginia*

Celestite and strontianite are found in vugs in dolomite of the Cayuga group (Silurian) in a quarry about one-half mile east of East Stone Gap, Wise County, Virginia. Most of the celestite crystals are elongated parallel to the a axis, and the (011) faces predominate. Other important faces observed are (101), (100), (210), (001), (211), (122). In all cases (100) is deeply striated and (011) is badly etched. A few tabular crystals, flat-tended parallel to (001) were observed. Other forms on these tabular crystals are (101), (011), (100), (210), and (111). The strontianite occurs as globular masses which vary in size from very small to a half inch in diameter. The globules have a radial structure and are vitreous to dull. Usually the strontianite is intimately associated with badly etched celestite, which suggests that it was formed by the reaction of weak carbonic acid waters upon the sulfate. A semiquantitative spectrographic analysis shows that 15% CaO is contained in this mineral, making the material *calciostrontianite*. X-ray diffraction values also show a significant chemical departure from pure strontium carbonate. Small amounts of yellow-brown sphalerite are at times closely associated with the strontium minerals. Colorless and honey-yellow calcite scalenohedrons, apparently not intimately associated with celestite and strontianite, were also collected in the quarry. Some excellent scalenohedrons twinned on (0001) were noted.

13. DESCRIPTION OF THE CONCRETIONS FROM THE MILLBORO BLACK SHALES.

Clarence E. Roberts and George T. Farmer, Jr.; *University of Virginia*

Millboro concretions were collected from a zone extending from Pendleton County, West Virginia to approximately one mile northeast of Clifton Forge, Virginia. The concretions have been found to range from about $3/8$ of an inch parallel to the long axis and $1/4$ of an inch in

thickness, to eight feet parallel to the long axis and one foot in thickness. Generally, they are flattened with their long axis parallel to the bedding of the surrounding strata. Secondary zones of calcite and barite may be seen filling the joints in many of the specimens. Externally, three distinct types of concretions are noted: (1) those that have a smooth exterior; (2) those with a rather rough exterior containing indications of bedding; and (3) those containing radial fibrous barite crystals forming the exterior margin. Internally, the first type consists of a dense black calcareous matrix with uniformly fine-grained crystals of pyrite concentrated near the outer margin. The second type contains large unoriented barite crystals and pyrite is occasionally embedded in the barite and concentrated in zones parallel to the bedding. The third type usually shows good zoning. The outer portion is composed of a uniformly fine-grained matrix usually containing euhedral crystals of pyrite and barite. The interior zone commonly shows a concentration of euhedral pyrite and radiating barite septarian structures. Septarian structures are always associated with the concretions which contain radial fibrous barite crystals along the outer margin.

14. BASAL CONGLOMERATE IN MOSHEIM LIMESTONE IN RICH VALLEY, SMYTH COUNTY, VIRGINIA.

Fred Webb, Jr.; *Virginia Polytechnic Institute*

The Mosheim limestone of early Middle Ordovician age disconformably overlies the Knox dolomite of late Early Ordovician age. The surface of disconformity is the result of erosion of the Knox prior to the deposition of the Mosheim, evidenced by the presence of breccias and conglomerates of Knox-derived dolomite and chert in the Mosheim limestone. The breccia and conglomerate are usually best developed at the base of the Mosheim. Inliers of Knox dolomite surrounded by Mosheim are common and the largest one attains an area of about 1.5 acres. The maximum relief developed on the surface of erosion in this area is about 460 feet. The disconformity is evidence that the Knox was above sea level during part of post-Early Ordovician, pre-Middle Ordovician time. A eustatic change in sea level was probably responsible for the erosion as the missing interval is bounded by the uppermost Lower Ordovician and the lower-most Middle Ordovician known in the southern Appalachian region.

15. FAULTS AND FAULT BRECCIAS OF THE BLACKSBURG-SHAWSVILLE AREA.

John B. Deaton; *Virginia Polytechnic Institute*

Three major thrust faults are present in the Blacksburg-Shawsville area in southeastern Montgomery County, Virginia. The Shawsville and Max Meadows faults are considered to be low angle thrusts. The Salem

fault is a relatively high angle thrust. The Shawsville fault extends southwestward from the vicinity of Shawsville on U. S. Route 11 through the town of Christiansburg. A branch of this fault extends northward from Christiansburg through Blacksburg, and probably joins the main Pulaski fault trace to the northwest. The Shawsville fault may represent a branch of the Pulaski fault. The Max Meadows fault is also interpreted as a low angle thrust. Numerous Klippen occur on knobs and ridges northeast of the main fault trace. The Salem fault extends in a northeast-southwest direction parallel to the Shawsville fault and about two miles to the northwest. A thick zone of tectonic breccia, composed mostly of crushed dolomite and limestone, is associated with the Shawsville fault. A much thinner zone of breccia, thoroughly silicified, occurs along the Max Meadows fault. Relatively little deformation has occurred along the outcrop of the Salem fault. The Shawsville fault is cut north of Christiansburg by the Salem fault, indicating that the Salem fault is younger. In the vicinity of Shawsville, the Shawsville fault trace is covered by the Max Meadows fault block, suggesting that the Max Meadows fault also is younger than the Shawsville fault.

16. PRIMARY SEDIMENTARY FEATURES IN THE UPPER MISSISSIPPIAN OF MERCER COUNTY, WEST VIRGINIA, AND GILES COUNTY, VIRGINIA.

William Andrew Thomas; *Virginia Polytechnic Institute*

The Upper Mississippian clastic sequences in the Mercer-Giles county area are divided into four formations: in ascending order — Bluefield formation (1000 feet), Hinton formation (1200 feet), Princeton conglomerate (30 feet), and Bluestone formation (700 feet). The formations are exposed on both flanks of the overturned Hurricane Ridge syncline. Penecontemporaneous slump structures occur in the upper Hinton and lower Bluestone formations in a heterogeneous sequence of maroon-drab mudstones, gray clay shales, maroon fine-grained sandstones, light-brown medium-grained sandstones, and argillaceous limestones. Small flow casts on the under surfaces of some sandstone beds which rest on mudstones demonstrate the importance of differential compaction in soft sediments. At Athens, Mercer County, a local body of limestone is warped into an asymmetric syncline, which is truncated by a massive sandstone and limestone-pebble conglomerate. The total stratigraphic interval involved is less than 40 feet. In a sandstone lens near Bluefield, Mercer County, the individual beds are highly deformed and disordered in dip of up to 70° are noted. Deformation of these units is attributed to differential compaction and slumping of underlying materials. On the northwest flank of the Hurricane Ridge syncline local exposures of contorted bedding, limited to a few feet both stratigraphically and laterally, occur as mild undulations in otherwise undisturbed beds. A fault of few feet displacement is exposed in similar

setting near Rich Creek, Giles County. The origin of these structures is attributed to slumping and sliding of soft sediments into the trough of the syncline.

MEDICAL SCIENCES

1. EFFECT OF INSULIN ON GLUCOSE UTILIZATION BY FROG SKELETAL MUSCLE *in vitro*.

D. R. H. Gourley; *Department of Pharmacology, University of Virginia*

In contrast to its effect in rat muscle, insulin has never been found to influence glucose utilization in frog muscle when the experiment is performed at the usual temperature of 20°C. At 24°C, however, in the presence of 0.02M glucose, insulin increases the oxygen consumption of intact frog muscle by 27% and the final glycogen content of the muscle increases by 10%. The utilization of glucose increases by 104% when insulin is present. Qualitatively, therefore, there is no difference in the *in vitro* effects of insulin thus far studied in the skeletal muscle of the frog and rat.

2. THE PRODUCTION OF HEMORRHAGIC IRREVERSIBLE SHOCK IN THE CAT.

Eugene D. Brand; *Department of Pharmacology, University of Virginia*

An improved method for the production of irreversible shock in the cat consists in maintenance of hemorrhagic hypotension at 40 mm Hg for 5 hours followed by return of all of the animals blood. Some advantages of this procedure are: (1) no acute deaths during hemorrhagic hypotension; (2) artificial respiration not required; (3) uniform and consistent course of gradual failure of the blood pressure to death; and (4) duration of survival can be predicted from the amount of automatic reinfusion and the amount of hemoconcentration resulting from the period of hemorrhagic hypotension.

3. AN INTERSPECIFIC STUDY OF PER CENT FATNESS AND OF WATER CONTENT OF THE FAT-FREE BODY.

Grover C. Pitts; *Department of Psychology, University of Virginia*

This study was based on 116 wild mammals of 29 species and 13 families and was supplemented by recalculations of published data on 10 additional species. The range in gross body weight was 3 to 130,000,000 grams. Fatness was determined by petroleum ether extraction and body water by freeze-drying. Log body fatness (%) plotted against log fat-

free body weight (FFBW) yields a straight line with a positive slope. This suggests a power function. An analysis of this relationship in terms of the energetics of fat storage and transport is presented. Evidence is presented that per cent water in the FFB is not constant from species to species as was previously assumed but is an inverse function of FFBW. It ranges approximately from 79% in the shrew to 71% in the steer. It is suggested that this range reflects a variation in fraction of low-water components present.

4. METABOLIC STUDIES ON FROG SKIN EPITHELIUM AND EPITHELIAL HOMOGENATE.

Leif Skjelkvale, Kathryn Nieder and Ernst G. Huf;
Medical College of Virginia

In spite of the frequent choice of frog skin in studies on active ion transport there is a great paucity of knowledge about metabolic pathways in skin epithelium. To fill the gap, work was begun on intact epithelium and homogenates. A simple method will be described whereby epithelium can completely be removed from the corium. Comparative data will be presented on mineral composition and O_2 uptake of epithelium and whole skin. O_2 uptake of epithelium suspended in Ringer's was measured in the absence and presence of metabolites, inhibitors, competitors. Unexpected difficulties were encountered in the preparation of epithelial homogenates. Stable homogenates can be prepared, however, in isotonic KCl. Such preparations have a very low O_2 uptake unless the medium contains as essential factors: metabolites (e.g. pyruvate and fumarate), Mg, ATP, TPP, cytochrome C, liver concentrate. The influence of pH, Ca, Mn, thiocetic acid was also studied. Epithelial homogenates contain a factor which strongly inhibits the respiration of kidney homogenates and, most likely, depresses the respiration of epithelial homogenate itself.

5. URINARY BLADDER RESPONSE IN THE CAT TO STIMULATION OF THE THALAMUS, HYPOTHALAMUS, BASAL GANGLIA AND OTHER FOREBRAIN STRUCTURES.

Everett H. Ingersoll, Louise L. Jones and Erling S. Hegre;
Department of Anatomy, Medical College of Virginia

The response usually obtained was characterized by a sustained diminution in the volume of the vesicle which generally could be abolished by section of the pelvic nerves. Occasionally stimulation elicited an immediate contraction of the bladder musculature which was followed in a few seconds by a prolonged relaxation. Again this response was abolished usually by section of the pelvic nerves. In other cats, inhibition of rhythm together with increased volume was evoked by stimulation. Such responses could usually be abolished either by section of the pelvic nerves

or by changing the frequency of the stimulus. This investigation was supported in part by research grant B-704 from the National Institute of Neurological Diseases and Blindness.

6. EFFECT OF EXPOSURE TO COLD ON THE RESPONSE TO ALCOHOL INTOXICATION OF RATS WHICH ARE DEFICIENT IN TRYPTOPHAN AND NIACIN.

J. C. Forbes and G. M. Duncan; *Medical College of Virginia*

We have reported that rats in which a niacin deficiency was induced by feeding a diet lacking both tryptophan and niacin, showed diminished adrenal response to alcohol intoxication. We now report that rats with this deficiency showed decreased resistance to alcohol after exposure to cold (2-5°C) for 3 days. One-third of the deficient animals died from 1-6 hours after alcohol while no deaths occurred in pair-fed controls under the same conditions. The rate at which alcohol disappeared from the blood was also definitely less in the deficient rats than in controls, in the cold or at room temperature. Exposure to cold caused an increase in the rate of alcohol clearance from the blood in all animals; this was marked only in the pair-fed controls. Exposure to cold for 3 days also depleted the already low liver glycogen of the deficient rats but after 7 days in the cold there was a return toward the original values. Alcohol given to deficient and control animals caused a drop in the liver glycogen at room temperature as well as in the cold.

7. A STUDY OF THE DEVELOPMENT OF THE SACROCOCCYGEAL REGION OF HUMAN EMBRYOS AND FETUSES.

James E. Kindred; *School of Medicine, University of Virginia*

The object of this investigation is to record the types of tissues and organs which develop in the sacrococcygeal region of the human embryo during fetal life. Thus fifteen young human embryos from 2 to 15 mm. in length have been studied by reconstruction from sections; and the sacrococcygeal region from 20 fetuses from 20 mm. to 250 mm. (CR) long have been studied directly in parasagittal sections. The kinds of tissues present, their waxing and waning, their mitotic activity and their fate have been recorded as far as possible in semi-quantitative fashion.

8. HYPOTHERMIA IN THYROIDECTOMIZED RATS.

Chalmers L. Gemmill; *Department of Pharmacology, University of Virginia*

The work on hypothermia in rats has been continued by measuring body temperatures and pulse rates at an ambient temperature of 9°C. Under pentobarbital sodium anesthesia, the response is related to body size. The smaller rats have a progressive fall in body temperature and pulse rates while the larger rats maintain their temperatures around 30°C

for two to three hours after the primary fall. Later, there is a secondary fall although a few rats have had a recovery from the 30°C level. Thyroidectomized rats, regardless of size, have only a progressive fall in temperature and pulse rates from the start of the experiment. Rats on 3,3',5-triiodothyronine have a moderate fall in temperature and pulse rates and a more rapid recovery when compared to the normal and thyroidectomized rats.

9. EXPERIMENTALLY PRODUCED REGENERATION OF ADULT FROG LIMBS.

Theodore I. Malinin; *Department of Pathology, University of Virginia*

Limb regeneration does not occur in adult anurans under ordinary circumstances. However, it was demonstrated that regeneration can be brought about by implantation of embryonic and young tadpole tissues into adult anuran limbs several days prior to their amputation. Heat killed larval tissues were also capable of promoting regeneration, while agar implants prevented normal healing and eventually produced foreign-body granulomas. About one hundred and eighty animals were used in these experiments. The regenerating limbs were examined histologically at various intervals. It became apparent from these observations that live implants are capable of survival in the host for long periods of time, that they do not cause foreign-body reactions, and that some of these contribute cells to the regenerates. However, these cellular contributions are not essential for initiating regeneration since heat killed implants are also capable of promoting regeneration. It is concluded that some physiologically active substances are produced by the implants and that these substances act to produce regeneration.

10. CLINICAL AND EXPERIMENTAL STUDIES ON NEPHROSIS.

Cornelia Hoch-Ligeti; *School of Medicine, University of Virginia*

It was found that nephrotic children with high serum lipoproteins excrete no lipoprotein in the urine although all protein fractions could be demonstrated. This observation was confirmed with rats rendered nephrotic by injections of aminonucleoside. In rats the sequence of changes in several enzymatic reactions, morphological changes, and fat deposition in the kidney, were related to the occurrence of albuminuria, ascites and changes of protein and lipoprotein distribution in serum and in urine. It is suggested that the lipid is split off from the protein in the kidney with both components being excreted separately.

11. X-IRRADIATION OF RAT CENTRAL NERVOUS SYSTEM.

Robert H. Brownson; *Department of Anatomy, University of Virginia*

It is the design of this experiment to analyze in some detail, the neurocytological, neurohistochemical and behavioral reactions in acute

and chronic stages following exposure to x-irradiation. Approximately 120 male rats 9 months of age were divided into acute, chronic and control groups. Exposures were made at the rate of 250/r/minute until each animal had received a total head irradiation of 1000r at weekly intervals. Irradiation was continued each week until such cumulative totals had reached 5000r. Glycogen, methyl green pyronin, phospholipids and lipid histochemical studies were employed in conjunction with Weil, Nissl, azocarmine and Marchi cytological methods. Chronic animals whose post-irradiation time is in terms of months and years are being tested psychologically for behavioral changes. In addition to the behavioral studies, tissues are examined by methods identical to those utilized in the acute phase of this study. Electroencephalogram 4-channel recordings and chemical analysis for total brain lipids have been collected on representative samples from each of the acute levels of x-irradiated animals and is currently being examined.

12. OVARIAN PREGNANCY.

Bernard A. Heckman and Delilah A. Little (Introduced by James E. Kindred); *School of Medicine, University of Virginia*

Ovarian pregnancy is quite rare. The specimen to be described was obtained from the Department of Pathology to which it had been sent for confirmation of diagnosis. When we received the specimen it had been sectioned so that only parts of the 8 mm. fetus remained. The chorion covered with many villi was embedded in the ovary. There was a large chronic cavity in which floated a piece of the embryo. Sections through the wall of the chorion showed that it had burrowed into the ovary and become attached in the region of the corpus luteum of pregnancy. The pregnancy was apparently of secondary rather than primary origin, that is, the ovum had developed to a certain degree in the uterine tube, been discharged through the abdominal os, and become secondarily attached to the ovary. It does not appear to have arisen from an ovum fertilized in the ovary.

13. ANOMALIES OF THE UMBILICAL CORD IN HUMAN EMBRYOS AND FETUSES.

Burton D. Goodwin and William M. Runkle (Introduced by James E. Kindred); *School of Medicine, University of Virginia*

The anomalous umbilical cords described here are those which have been collected by the Department of Anatomy from specimens sent to us by the Departments of Obstetrics and of Pathology. Some of the simple forms of knots and foldings are said not to be harmful to the fetus unless drawn tight to close off the intrauterine circulation. Another kind of tight entanglement around the neck has resulted in the contraction of

the neck to such a degree that the head has lost its characteristic features. In a 15mm. embryo an umbilical cord has fused with the sacral region of the body and wrapped itself around the body in such a way as to form a sac enclosing the hind limb-buds. The mesoderm of the body and of the cord are continuous. This condition is accompanied by rachischisis and malformations of the more cephalic parts of the body.

14. HUMAN MONSTER WITH ABNORMAL DEVELOPMENT OF THE AMNION.

David S. O'Brien and Charles L. Gaudry, Jr., (Introduced by James E. Kindred); *School of Medicine, University of Virginia*

This report is a description of a human term female monster in which faulty development of the amnion damaged extensively the anterior surface of the head and body. The fusion started with the face which is disfigured by the invasion of the amnion around the nose and down into the throat. The amnion emerges from the throat and passes across the chin to become fastened to the body wall in such a way as to interfere with the normal development of the sternum and heart. Below this the body appears to be normal as far as the umbilicus, but below this there is a large hernia thru which the liver and intestine project. This is one of the few anomalous conditions in which the amnion is involved to a fatal degree.

15. DESCRIPTION OF FULL TERM MALE "SIAMESE" TWINS OF THE THORACOPAGUS TYPE.

James H. Carroway (Introduced by James E. Kindred);
School of Medicine, University of Virginia

These twins are joined at their ventro-lateral surfaces by a broad band of body wall containing the heart and liver, large arteries and veins. The larger twin is 279 mm. and the smaller 255 mm. long (CR). The total weight at birth was 9 lbs. 6 oz. The head of the larger twin looks normal, but that of the smaller seems to be deformed. The umbilical cords are joined at the umbilicus and a common umbilical vein enters the single median liver. The heart is broad and there is a systemic trunk for each twin. There is a common large broad atrium into which all of the veins empty. The duplicated viscera are mirror images of each other. Further details are to be presented after dissection.

16. DISSECTION OF A HUMAN CRANIOPAGUS PARIETALIS.

Robert B. Moore and Arthur H. Wasser (Introduced by James E. Kindred); *School of Medicine, University of Virginia*

Basic information concerning the anatomical relations between skin, meninges, vascular and nervous systems of twins joined by their crania

is not extensive. The female twins described here are joined by the tops of their heads and one faces in the opposite direction from the other. One body is 300 mm. and the other 320 mm. long. Their heads are joined broadly and the dissection will describe the conditions at the junction. Apparently the other parts of the body are normal.

17. DESCRIPTION OF A HUMAN FULL-TERM CYCLOPS.

Louis J. Elsas and John T. Hutchens (Introduced by James E. Kindred);
School of Medicine, University of Virginia

This specimen is characterized by a single abnormally developed eye in the center of a low forehead. Knobs of flesh are present in place of external ears. There is no nose and the mouth appears to be normal. In preliminary dissection it was found that the head had hydroencephaly, a condition in which fluid in the meninges has compressed the cerebrum and prevented its normal development. There seems to be two optic nerves going to a fused eye. The brain stem appears to be normal. Viscera are grossly normal morphologically. Histologic studies and more dissections are being carried on.

18. ANOMALIES OF KIDNEYS OF HUMAN EMBRYOS AND FETUSES.

Edwin L. Lyons, Robert K. Maddock, Jr. and Alan D. Rosenthal
(Introduced by James E. Kindred); *School of Medicine,
University of Virginia*

This report concerns the cytologic and morphologic relations of several varieties of metanephric malformations which have been found in the human embryos and fetuses in the collections of the Departments of Anatomy and of Pathology. The descriptions are of the following conditions: (a) horseshoe kidney in a 12 mm. embryo; (b) double kidney and double ureter in a 75 mm. fetus; (c) agenesis of secretory part of kidney and hypotrophic ureter; and (d) cystic kidney from biopsy of child.

19. ABSORPTION, DISTRIBUTION, AND EXCRETION OF METHOCARBAMOL.

Leah L. Eubank, Frances K. Coles, Addison D. Campbell and Ernst G. Huf; *Medical College of Virginia*

Absorption, distribution and excretion of methocarbamol were studied in normal and pregnant dogs and total urinary excretion of methocarbamol in man was investigated. In acute experiments on anesthetized animals, the dogs received C¹⁴ labeled drug or unlabeled material into a loop of the small intestine. Methocarbamol distributes itself throughout the body and, when given in a relatively large dose, is found in tissues in concentrations higher than expected upon the basis of simple diffusion equilibrium between blood and tissue fluid. Lipoid from several tissues contained less methocarbamol than the residue of those tissues. At best,

84% of the administered dose could be recovered from urine, bile, blood and the main soft tissues. In chronic experiments dogs received methocarbamol orally, daily, for two weeks. Then the drug was withdrawn. Less than 1% of the total administered dose was found in the chief soft tissues one day or a few weeks after withdrawal of the drug. When a single dose of C^{14} methocarbamol was given orally to dogs, it was found that 50 to 90% of the activity appeared in the urine, and 10 to 12% in the feces on the first day. Only small amounts of C^{14} active materials appeared later in the urine and feces or remained in the tissues. In 2 out of 4 dogs so treated, all C^{14} activity administered to the dogs was recovered in urine, feces and tissues, the latter contributing not more than about 2% to the total. Methocarbamol permeates across the placenta into the fetus. It was found in amniotic fluid, cord blood, blood and several organs of the puppies; and it also appeared in the bitch's milk. Two human volunteers ingested methocarbamol for three consecutive days. Quantitative urine collections were made. The urine was analyzed for methocarbamol before and after acid hydrolysis. Less than 1% of the drug given appeared in the urine in free form. After hydrolysis about 10% could be recovered. Similar data were obtained in studies on dogs.

PSYCHOLOGY

1. PAINLESS ELECTRICAL CUTANEOUS STIMULATION.

Robert H. Gibson; *University of Virginia*

Arousal of cutaneous sensations by electrical stimulation of the skin is frequently accompanied by pain. The value of such stimulation, both for research and for communication purposes, would be enhanced were pain eliminated. The present investigation seeks to determine some relevant conditions for painless cutaneous electric stimulation. Single, suprathreshold envelopes of alternating current have been presented to several body loci. Two frequencies, two sizes of active electrode, and several envelope durations have been independently manipulated, using the subject's report as an indication of pain. At some body loci, higher frequencies were reported as painless.

2. SHORT TERM MEMORY IN A SEQUENTIAL TASK.

John B. Feallock; *University of Virginia*

The task studied is one in which stimuli are presented sequentially to a subject and he must recall them when they are asked for, one at a time. Since the presentation and recall of any given stimulus may be

separated by the presentation or recall of other stimuli, it is sometimes necessary for the subject to remember several stimuli while he is recalling one of them. In the present study the average number of stimuli that must be remembered at recall occasions defines the concept of "average storage load." Average storage load was manipulated as an independent variable, and its effects upon performance were assessed in terms of recall scores. It was predicted that recall errors would increase with average storage load. Analysis of errors scores indicated that both average storage load and subjects were significant variables of performance. As predicted, error scores increased systematically with average storage load.

3. THE INTERTRIAL INTERVAL IN AVOIDANCE CONDITIONING.

Raymond H. Kirby; *College of William and Mary*

Four groups of ten rats each were given 51 instrumental avoidance conditioning trials in a shuttle-box. The CS was a buzzer and the US was electric shock. Two groups were trained under intertrial intervals of 15 to 60 seconds respectively. Two other groups had five minutes and thirty minutes rest intervals interpolated after every fifth trial. A pseudoconditioning control group of ten rats was matched to the 60 second group. It was found that a 30 minute-rest interval reliably decreased avoidance responding below the 60 and 300 second-rest groups. Intertrial interval had no reliable effect.

4. PARTIAL RECOGNITION, WORD FREQUENCY, AND RESPONSE BIAS.

William Forrest Hawkins; *University of Virginia*

Does increasing the frequency of a word lower recognition thresholds? Recent studies have suggested that the word-frequency — recognition threshold relationship may bear no relation to perception. This study investigated the role that perception does play in recognition experiments, and focused on partial recognition. Nonsense syllables were divided into three families of seven words, each family having the same mid-letter. Frequency of training was varied in each family. In a recognition session, different visual presentations were used. For one group of Ss, and, for the third group, the total word was presented. The previously reported relationship between word-frequency and frequency of response was supported. The part that perception played seemed to be one of reducing response alternatives.

5. ATTITUDES OF PARENTS AND EDUCATORS TOWARD SEX EDUCATION IN PUBLIC SCHOOLS.

Cyril R. Mill; *Department of Mental Hygiene and Hospitals*

Several years ago the State Department of Education removed

from the approved list a variety of texts, films, film-strips, and pamphlets relating to human reproduction, dating, marriage and family life. This investigation, sponsored by the Virginia Council on Family Relations, is to determine current policy at the State and local levels. Analysis is made of the returns obtained from a questionnaire sent to all school principals in Virginia, and to all P.T.A. units, where they were asked to indicate which of a variety of topics in sex education are presently being taught, are not being taught, and which they do not wish to be introduced into the curriculum. Differences in attitudes of parents and educators toward sex instruction in public schools will be pointed out.

6. NON-SEX BEHAVIOR CHANGES INDUCED BY AN ESTROGEN.

Robert L. Rhyne; *University of Virginia*

Mature male albino rats had free access to food, water, and revolving activity drums under a 12 hour dark-12 hour light cycle. Following three subcutaneous injections of estradiol benzoate (0.25 mg every other day) food consumption was drastically reduced and somewhat depressed throughout the recovery period; water consumption was less markedly depressed, while rotor wheel activity evidenced both variable and inconsistent changes. Maximal weight losses under the drug effect ranged from 2 to 12 percent of body weight. The present results suggest that an estrogen has conspicuous motivational "side effects" besides the "sex behavior" properties classically ascribed to this kind of hormone.

7. CONSTRUCTION AND EVALUATION OF A MODIFIED FORM OF THE IOWA PICTURE INTERPRETATION TEST.

David G. Rice; *College of William and Mary*

The Iowa Picture Interpretation Test (IPIT) was modified by placing all multiple-choice responses along an achievement imagery (AI) scale, instead of the hostility, insecurity, bland and AI response scales used for each picture in the original IPIT. There was no difference between high and low academic achievers on this form, using a criterion of grade average in excess for below predictions from an entrance test. A second criterion showed similar negative results. Item analysis suggested that the measure could be improved by reweighting the items, whose original weights had been assigned on the basis of judges' ratings to various response sentences.

8. A SECOND REPORT ON ACHIEVEMENT IMAGERY AND A. C. E. SCORES AS PREDICTORS OF GRADES IN GENERAL PSYCHOLOGY.

John E. Williams; *University of Richmond*

The academic performance of four hundred students in general

psychology was studied in relationship to scores on the A. C. E. Test — a measure of scholastic aptitude for intelligence — and scores on the Achievement Imagery scale of the Iowa Picture Interpretation Test. The IPIT is a multiple-choice form of the T. A. T. The main finding was that high Achievement Imagery exerts a beneficial effect on academic performance at low and average levels of intelligence but produces no effect among students in the highest quartile of intellectual ability. It was concluded that the results of this study should encourage attempts to devise objective measures of non-intellectual factors influencing academic performance.

9. THE EFFECT OF FAILURE AND ACHIEVEMENT IMAGERY ON ARITHMETIC PERFORMANCE.

R. A. Johnston; *University of Richmond*

The purpose of this investigation was to replicate an earlier study by Williams which showed differential response to failure by groups differing in Achievement Imagery and secondly to investigate the capacity of the Insecurity Scale of the Iowa Picture Interpretation Test to predict response to failure. For one-half of the subjects failure was induced by telling them they had not reached goals which they, themselves, had set and one-half were told that they had failed to reach goals set by the experimenter. The results suggested that both the Achievement Imagery and Insecurity variables were related to performance following failure and that the responses of these groups were dependent on whether the goal setting was done by the subject or the experimenter. It was also pointed out that the actual performance of subjects following failure was not well understood.

10. VISUAL FEEDBACK AS A VARIABLE IN A HUMAN PUZZLE BOX SITUATION.

Henry A. Schwartz; *College of William and Mary*

This experiment was designed to determine the effects of four different amounts of visual feedback on latency, amplitude, rate and stereotypy measures of a motor operant response in humans. Subjects were required to learn to trace a path with a pen to a location on a sheet of paper. Each S was scored for latency, length of line traced and amount of stereotypy exhibited during 15 acquisition trials. Visual feedback was found not to affect any of the measures taken. It was found that the classical measures of latency, amplitude and rate did not adequately describe the behavior in this situation.

11. AF: A NEW APPROACH TO THE CONCEPT OF ACHIEVEMENT.

Robert M. Roth and Jean Gilbert; *Hampton Institute*

This study tested the hypothesis that the Achievement Factor (AF),

the relative difference between a student's aptitude and achievement in the verbal and quantitative areas, could be used as a valid indicator of academic success at Hampton Institute. Aptitude and Achievement test scores were correlated with grades at the end of the first semester for the class of 1960. The results indicated that the level of relationship was inadequate. Significance was achieved when AF was related to grades. There was a sex bias in these results. It was indicated in this study that academic achievement is related to personality factors and that much more research is necessary in this area. The AF concept is a suitable approach to this end.

12. INVESTIGATION OF THE EFFECTS OF A BRIEF LIGHT STIMULUS CONTINGENT UPON A RESTRICTED VERBAL OPERANT IN HUMAN SUBJECTS.

John R. DeWilde; *College of William and Mary*

The effects of a brief light stimulus contingent upon plural noun responses were studied under three experimental conditions: light deprivation, making a consumatory response to the light, and presence or absence of the experimenter. Seventy-nine undergraduate subjects were seated individually in a sound resistant room and instructed to say words. Following operant level determination experimental subjects received the light stimulus for plural nouns. Control subjects received either no light or light presented randomly with respect to the words emitted. The results failed to confirm previous studies which have shown that a brief light stimulus will reinforce verbal operant behavior.

13. THE "DOCTOR OF PSYCHOLOGY" AS A PROFESSIONAL DEGREE.

Dell Lebo; *Child Guidance and Speech Correction Clinic, Jacksonville,*
and Leland W. Calvin, Jr.; *Richmond Professional Institute*

There has been agitation in psychological journals to abandon the academic PhD and confer a professional doctorate in psychology, PsyD or PsD. Psychologists should be aware that the Doctor of Psychology degree has been available to charlatans for approximately 35 years from state chartered organizations. Doctorates from rigorous training programs may become confused with similarly worded degrees lavishly bestowed upon completion of bizarre course requirements. Professional relationships are jeopardized. The number of such peculiar establishments is increasing; eight are cited and the requirements of four are examined. Methods of distinguishing between bona fide diplomas and suspicious ones are presented.

14. DIFFERENTIAL DRUG EFFECTS ON SCHEDULES OF REINFORCEMENT IN THE PIGEON.

Arthur J. Bachrach and Janice Gibson;

University of Virginia School of Medicine

Using each bird as its own control, a Carneaux pigeon receiving 0.4 mg. methamphetamine hydrochloride decreased its pecking rate during both FR and FI schedules in a Skinner box, while one receiving 0.1 mg. methamphetamine hydrochloride increased its pecking rate. 3 mg. pentobarbital sodium returned the first bird to its normal rate of response while 1 mg. pentobarbital sodium decreased the rate of the second bird. To answer the question, "Does appetite loss cause the lower pecking rate after a large dose of methamphetamine?", both birds were fed ad libitum with and without methamphetamine injections. The amount of weight gain appeared the same.

15. ASSESSMENT AND EXTENSION, AND TEST OF OEDIPUS CONCEPT.

John T. Blue, Jr.; *Norfolk Division, Virginia State College*

The elements and construction of the Oedipus concept were assessed and the conceptualization was extended. More complex hypotheses were tested by using a questionnaire. The sample consisted of 606 white and Negro Southern adolescents with native-born parents. The incidence of patterns of reciprocation between each parent and the child on several axes of relatedness was determined, taking account of sex, race, and social status. Differences between mothers and fathers were found significant on all axes. Differences between mothers (as well as fathers) of children who differed by sex, race, and social status were noted. Tests of significance were applied, taking into account one factor while holding constant two other factors. The differences between mothers and fathers were significant when sex, race, and social status were taken into account. On certain axes of relatedness, sex, race, and social status differences emerged.

16. DRINKING BEHAVIOR AS A FUNCTION OF SALINE INJECTIONS AND WATER DEPRIVATION.

James F. Campbell, Jr.; *University of Virginia*

Rats were either injected with different concentrations of saline and denied access to water for intervals up to an hour, or were deprived of water for 24, 48, or 72 hours. Drinking during a two hour test was cumulatively recorded with an electronic drinkometer. The total amount drunk and the initial period of uninterrupted drinking increased with increasing deprivation and, except for the highest, with increasing concentration. Under deprivation the number of subsequent drinking periods remained constant, but the amount consumed increased with deprivation. With injection, although the amount consumed during subsequent periods increased with concentration, the number of periods varied with delay and concentration.

17. THE PRESENT STATUS OF RECORDED SOUND STIMULI ASSOCIATION TESTS

Dell Lebo; *Child Guidance and Speech Correction Clinic*, Jacksonville,
and Roselyn Sherman Bruce; *Social Service Bureau*, Richmond

The development of auditory projective techniques, all requiring recorded stimuli, for use with the blind is traced. The nature of the growth is regarded as dangerous and criticized. Specific suggestions for improvement range from a standard titling procedure to a fundamental research program. Much of the recommended experimentation on the dynamic meaning of sound stimuli can be justifiably conducted by means of associations to written words or sentences. It is pointed out further that diagnostic nuances may be overlooked by dependence on a TAT scoring system and that techniques developed to tap different sensory modalities should merit original scoring procedures.

18. A COMPARISON OF SCIENCE AND NON-SCIENCE STUDENTS ON THE MORGAN TEST OF LOGICAL REASONING.

Fred McCoy; *University of Richmond*

A report by Morgan before the Academy last year showed selected young scientists to get extremely high scores on the Morgan Test of Logical Reasoning. This study is a test of the hypothesis that scientists and non-scientists differ in logical reasoning ability and can be discriminated by the Morgan test. 95 college students were given the Morgan Test. Logic scores were found to be significantly related to intelligence. Holding intelligence constant by analysis of covariance, there was no difference in logic scores between (1) men and women in the sample, and (3) three age groups in the sample. There was, however, a significant difference between people who had had an academic course in logic and those who had not. 48 (forty-eight) seniors, none of whom had taken a course in logic were divided into three groups: (1) science majors (chemistry, physics, biology); (2) non-scientist majors (English history, bible, music, languages, drama, and physical education); and (3) mathematics majors. And each of these three groups was compared at three levels of intelligence. The results showed that math majors were superior in logic scores to both scientists and non-scientists, who did not differ from each other. On the lowest level of intelligence, there was no difference between the three majors, but this interaction was not significant.

19. A DISCUSSION OF CONCEPTS OF PLAY.

Jacob Silverberg; *Veterans Administration*

The theories of play which have been advanced in our present culture and which assume that it is an activity solely relegated to the world

of the child, that because it is not work it is not serious activity, are distorted representations of behaviors which are seen here as vital in creating prototype situations for the child, as well as for the adult, in mastering reality and contributing to the development and creative growth of *identity*. That Western civilization has been increasingly losing its "playful" character is menacingly apparent. It is the interplay of work and play, rather than their disjointed separateness which can be most conducive to human development.

20. NINE YEARS OF DIAGNOSIS AND TREATMENT AT THE LYNCHBURG COLLEGE READING CENTER.

William D. Brown and Louann Bolden; *Lynchburg College*

From 1949 through 1958 two-hundred and thirty subjects were diagnosed and/or given instruction to help alleviate their reading deficiency by the Lynchburg College Reading Center. From data supplied by the files at the Center and questionnaires answered by the parents, a survey was administered concerning the value and help given by the Center. Emotional, educational, and physiological factors were considered, as they contribute to reading problems. However, these factors are complex and remedial reading instruction is more effective when undertaken in conjunction with consideration of disturbances in other areas of human functioning.

21. DETECTION AND RECOGNITION THRESHOLDS OF NON-UNIFORM VISUAL TARGETS.

E. Ræ Harcum; *College of William and Mary*

In three target surfaces a unit of surface microstructure was black or white depending upon whether it was different from the brightness of the adjacent preceeding unit in an arbitrary sequence 100, 75, or 50% of the time, respectively. Previous research found lowest detection thresholds for the 50% (random) microstructures, and highest thresholds for the 100 % (checkerboard) surfaces, but frequently the reverse for recognition thresholds. Present preliminary results suggest that whether thresholds vary significantly as a function of target surface microstructure is dependent upon: (a) target area; and (b) observer's criterion level for detection or recognition.

22. THE LOWRY REASONING TEST COMBINATION AS A STATUS-FREE DEVICE FOR A PERSONNEL SELECTION PROBLEM.

R. S. Andrews; *QM Field Evaluation Agency*, R. O. Lucier; *Courtney and Co.*, and Dell Lebo; *Richmond Professional Institute*

The Lowry Reasoning Combination (LRC) and portions of the

Army Classification Battery (ACB) were evaluated to determine relative efficiency for identifying the maximum number of individuals capable of satisfactory performance on a job requiring above-average intellectual functioning. The method of equal-appearing intervals was adapted to the development of a performance rating form which was used by supervisors to rate job incumbents. Application of appropriate statistical techniques to the results indicated that the LRC is most efficient in predicting job performance, least influenced by level of education, and provides a simple, relatively status-free device for personnel selection.

23. COUNSELING WITH A GROUP OF MENTALLY RETARDED CHILDREN IN A PUBLIC SCHOOL SETTING.

Cora Lynn C. Goldsborough; Arlington County Schools

The class in which these counseling sessions took place was a group of educable mentally retarded children at the intermediate level in an elementary school. The class consisted of a mixed group of boys and girls whose ages ranged from ten to thirteen years. The purpose of the sessions was to discuss and encourage better social adjustment, looking towards the transition to classes in a junior high school. The sessions were held on a regular weekly basis for a half hour with the school psychologist as leader and the teacher as an aid. A variety of techniques was employed to maintain the children's interest and participation and to reinforce the point brought up. In addition to discussion use was made of role playing, picture drawing, chart making, and real life situations. Their teacher who sat in on the sessions continued a carry over of points made during the intervening week. Over a six months period definite changes of attitude within the group towards each other were noted as well as a carry over into a better handling of social situations outside the school situation.

24. THE OLFACTORY SENSITIVITY OF THE RAT TO SOME HOMOLOGUS HYDROCARBONS.

William R. Goff; University of Virginia

The sensitivity of albino rats to the odors of three homologous, saturated hydrocarbons has been measured using a previously reported olfactometer. Odors are presented by injecting them into an air stream flowing continuously through a "wind tunnel" response chamber in which the animal is bar pressing. A discrimination is established between presence and absence of odor in which presence of odor signals cessation of response. Training is continued as concentration is progressively lowered until discrimination fails. If the ratio of responses during odor to responses during a non-odor control stimulus is plotted as a function of log

concentration, the result is a linear function which expresses the sensitivity of the animal.

25. TRAITS BY FIAT.

Henry E. Garrett; *University of Virginia*

Categories of behavior are often set up intuitively and are then described by test items which seem "logically" to measure them. Often these behavior categories are treated as though they constituted specific and well established trait dimensions. Unless the independence of such hypothesized traits can be demonstrated experimentally, however, vocational or educational advice based upon apparent differences among them will be useless if not definitely misleading. Illustrations of "fiat" traits are given.

SCIENCE TEACHERS

1. SETTING AND MAINTAINING STANDARDS IN TODAY'S SCHOOLS.

Franklin D. Kizer; *Assistant Supervisor of Secondary Education*

The State of Virginia has been allotted, under the National Defense Education Act, \$466,360 for the current fiscal year for the acquisition of equipment. This is to be matched, dollar for dollar, by local funds. Mr. Kizer discussed the requirements that must be met in order to receive such funds and the equipment allowed and explained the procedure which should be employed when applying for aid.

2. WHAT THE VIRGINIA JUNIOR ACADEMY OF SCIENCE HAS MEANT TO ME.

Joanna Hackman; *Hollins College* and Robert Dunning; *University of Richmond*

Miss Hackman, a 1953 graduate of Radford High School, praised the Virginia Junior Academy of Science for the interest, opportunities, encouragement, and guidance which it gave her as a high school student. She also gave a sketch of the work she has done on her project while in college and of the awards she has received since her high school days.

Mr. Dunning, a 1953 graduate of Norview High School, told how the Virginia Junior Academy of Science gave him an incentive to undertake his first project and how meeting and talking with senior members of the Academy has helped him in his work.

3. RESEARCH AND TECHNIQUES TO RAISE THE LEVEL OF INSTRUCTION IN PHYSICS AND GENERAL SCIENCE.

Edward North; *Washington and Lee High School*

Mr. North's objective is to teach physics to as many students as possible. He does not believe "in bending the course to suit the student but rather to bend the student to fit the course." He stated that he sells his physics course on how "tough" it is.

Some of the techniques which Mr. North stressed are:

1. Extra-curricula activities should be related to classwork.
2. Classroom work must be the most important part of a course.
3. Laboratory manuals and textbooks should be used only as reference books.
4. The number of experiments should be reduced and the experiments used should cover a large area. Data obtained from previous experiments should be used.
5. Students should be screened and the special ones put into one class.
6. Classical physics should be taught.
7. A science teacher should have only four classes and no homeroom.
8. Algebra and science classes should be correlated.
9. There should be a follow-up study of students to see how effectively their science courses prepared them for their college work or their jobs.

4. RECENT ADVANCES IN CYTOLOGY.

Henry G. Kupfer; *Department of Clinical Pathology,
Medical College of Virginia*

Dr. Kupfer spoke of the necessity of laboratory work in medicine. He discussed the field of medical technology as a career and explained the training required, the opportunities, and the need for trained people in this field. A film, "The Human Cell and the Cytotechnologist," was shown.

5. THE ROLE OF THE VIRGINIA DEPARTMENT OF AGRICULTURE AND IMMIGRATION IN THE ECONOMIC GROWTH AND DEVELOPMENT OF VIRGINIA.

Parke C. Brinkley, *Commissioner,
Medical College of Virginia*

Mr. Brinkley explained the opportunities that face young people today in the field of agriculture. When young people leave the farm they need not leave the field of agriculture for science has now become an

important part of farming. He stated that there are 15,000 job openings per year in fields related to agriculture and only 7,000 degrees in agriculture granted per year.

BUSINESS MEETING.

The following officers were elected for the coming year: A. B. Niemeyer, Jr., *Chairman*; Virginia C. Ellett, *Chairman-Elect*; and Robert Horne, *Secretary*.

STATISTICS

1. APPLICATIONS OF COMPUTERS TO MEDICAL RESEARCH.

Frank W. Banghart; *University of Virginia*

Presentation of the results of three conferences held by the Air Force on the applications of computers to medical research. Topics will include applications of computers to brain functions, cellular activities, electrocardiography, electroencephalography, surgery, liver functions, insulin coma, psychiatric disorders, and hemodynamic systems.

2. LINEAR PROGRAMMING APPLICATIONS.

Norbert Lloyd Enrick and Sue Champney Lawrence;
Institute of Textile Technology

Linear Programming is a relatively new technique of mathematical analysis, which permits the selection of an optimum combination from a series of interrelated and interacting alternatives, each subject to limitations; as encountered in many industrial, economic and military problems. Investigative work at the Institute has been with regard to the industrial potentials of this tool, and several successful applications have been made, using an electronic computer (Burroughs Electro-Data E-101-3) to perform the actual calculations. An illustrative example, shows how the Simplex and Ratio-Analysis methods of Linear Programming may be used to develop an optimized solution. The example given is coded. Parallel applications of this technique to problems in industry in general becomes apparent.

3. TRAFFIC VOLUME ESTIMATES PROBABILITY APPLICATIONS.

Marvin Tummins; *Virginia Council of Highway Investigation and Research*

The average daily volume of traffic moving over a particular high-

way during the year, commonly called ADT, is a measure of service of that highway and thus is of particular importance. Also, in order to administer highway activities and to evaluate requirements, information about characteristics other than volume is needed. True values of ADT are difficult if not impossible to obtain. Continuous counting for 365 days is made almost impossible by various defects arising in mechanical counters. Estimating procedures thus are made necessary. Probability techniques could result in estimates with measurable accuracy and precision and could combine estimates of volumes with estimates of other characteristics. In this study various probability applications are tried, tested for accuracy and precision, and then the various applications are compared. Each estimate is compared against known results. The emphasis is upon the use of small samples — 10 to 15 observations.

4. NOTES ON THE DETECTION OF WEAROUT.

C. W. Clunies-Ross; *Virginia Polytechnic Institute*

The exponential distribution may be characterized by the fact that the conditional "failure" rate is constant, i.e., lifetimes are distributed as the waiting time for the initial disturbance from a Poisson process the parameter of which is constant. One method of allowing for (irreversible) wearout is to consider the underlying Poisson process as one whose parameter is an increasing function of time. This paper investigates two statistical properties of such wearout. One property is that the differences between ordered observations which, with suitable multipliers, are independent, and identically distributed for the exponential distribution now form a stochastically monotonic, non-independent sequence. Another property is that the standard deviation is less than the mean. Statistical tests of these properties are proposed and discussed in general terms. Empirical sampling results are used to estimate the power of the tests for certain examples. Matched sampling is employed; this allows the use of stratified estimators for the estimation power.

5. A COMPARISON OF THE INTERNAL AND EXTERNAL ASSAY VARIATION IN THE VIRULENCE TESTING OF *BACILLUS ANTHRACIS* SPORES.

Ira A. DeArmon, Jr.; *Fort Detrick, Maryland*

Triplicate quantal response assays each using 40 mice were performed with each of eight strains of *B anthracis* spores by both the intraperitoneal and subcutaneous routes of challenge. The observed variances of the LD₅₀'s (internal) were contrasted to the variances between repeated LD₅₀'s (external). The external variance was homogeneous for the treatment conditions and was approximately 4 fold larger than the mean internal variance. It was concluded that the virulence of a strain of *B anthracis* spores can best be estimated by repeated LD₅₀'s based on

a small number of animals rather than a single LD_{50} determined from a large number of animals.

6. NOTE ON PRECISION OF GRADED VS ALL-OR-NONE RESPONSE IN BIOASSAY

F. M. Wadley; *Fort Dietrick, Maryland*

Graded and all-or-none responses are compared on a theoretical basis; for equally well adapted responses, we should expect the former to be a little over twice as precise. Examination of several cases supports this idea. Relative precision in an actual experiment may be compared by use of the variances. If one response is used, the precision necessary to match it for the other response can be estimated.

7. MULTIVARIATE SEQUENTIAL PROCEDURES FOR TESTING MEANS. (PRELIMINARY REPORT.)

J. Edward Jackson; *Virginia Polytechnic Institute*

Let $\underline{x} = [\mu_1 - \mu_{10} \quad \mu_2 - \mu_{20} \quad \dots \quad \mu_p - \mu_{p0}]$ Where μ_i

is the true mean of the i th variable in a p -variable situation and μ_{i0} is the hypothetical or standard value for the i th variable. Sequential tests are proposed to test the hypothesis

$$H_0 : \underline{x} \underline{\Sigma}^{-1} \underline{x}' = 0$$

against the alternative hypothesis

$$H_1 : \underline{x} \underline{\Sigma}^{-1} \underline{x}' = \lambda^2$$

both for the case where the population covariance matrix $\underline{\Sigma}$ is known and the case where it must be estimated from the sample. The standard type of sequential test procedure is to continue sampling when

$$\ln [\beta / (1 - \alpha)] < g_n < \ln [(1 - \beta) / \alpha],$$

accept H_0 if $g_n < \ln [\beta / (1 - \alpha)]$ and accept H_1 if $g_n > \ln [(1 - \beta) / \alpha]$.

$$\text{If } \bar{\underline{x}} = [\bar{x}_1 - \mu_{10} \quad \bar{x}_2 - \mu_{20} \quad \dots \quad \bar{x}_p - \mu_{p0}], \quad \chi^2 = n \bar{\underline{x}} \underline{\Sigma}^{-1} \bar{\underline{x}}'$$

and $T^2 = n \bar{\underline{x}} \underline{S}^{-1} \bar{\underline{x}}'$, then for the case when $\underline{\Sigma}$ is known

$$g_n = -n \lambda^2 / 2 - \sqrt{n \lambda^2} \chi^2 + \ln F_1 \quad (p - 1) / 2, p - 1; \quad 2 \sqrt{n \lambda^2} \chi^2$$

and where Σ is now known,

$$g_n = -n\lambda^2/2 + \ln {}_1F_1 [n/2, p/2; (n\lambda^2 T^2)/2(n-1+T^2)]$$

where ${}_1F_1[a, b; x]$ denotes a confluent hypergeometric function. Similar multivariate sequential tests are also derived for the problem of comparing the means of two samples.

8. ON COMPARING DIFFERENT TESTS OF THE SAME HYPOTHESIS.

H. A. David: *Virginia Polytechnic Institute*

D. R. Cox (Biometrika, 1956) suggested that a quick test should be compared with the corresponding standard test not only on the basis of power but also on the extent to which the quick test leads to the same conclusion as the standard test. Two approaches to such a comparison are considered in the present paper, namely the evaluation of: (1) The probability of establishing significance at a certain level with the quick test given that the standard test is *just* significant at some more stringent level; and (2) The probability that the quick test statistic will exceed its conditional expectation given a specified value of the standard statistic. It is shown that these two probabilities are under suitable conditions independent of the parameter θ under test. For example, it is sufficient that the standard statistic be a complete sufficient statistic for θ . The theory is applied to a comparison of the sample standard deviation, range and mean deviation as tests of variance in the case of a normal parent.

9. A STUDY OF MULTIVARIATE CONFIDENCE BOUNDS.

Rolf E. Bargmann; *Virginia Polytechnic Institute*

The present report discusses the construction of confidence bounds in three standard cases of multivariate analysis. After generalizing certain types of univariate distributions, we proceed to show that exact confidence bounds are available on some not too useful parametric functions, whereas the present approach does not succeed in determining the exact bounds of functions which are the parametric analogues of likelihood-ratio statistics.

10. TWO WAY RANK SUM TESTS FOR VARIANCES.

Abdur R. Ansari and R. A. Bradley; *Virginia Polytechnic Institute*

This paper deals with non-parametric two-sample tests of variances. We have proposed a test based on statistic W . In the paper a recursion

formula for probabilities in the exact distribution of W have been developed; tables for the exact distribution of W have been prepared for the combined sample sizes m and n up to 20, and higher order moments of W have been derived. A study of a normal approximation and a Pearsonian approximation to the statistic W has been made. The kurtosis and skewness of W indicate that for large sample sizes, the distribution of the statistic W approaches the normal curve. The asymptotic normality of W has been established, and its relative efficiency in the Pitman sense, as compared with the usual variance-ratio F -test, has been derived. We have also modified our statistic W . Later different procedures available in the literature have been compared showing the advantages and disadvantages of the test-statistic W and an example has been furnished to illustrate its use.

11. A COMPARISON OF THE EFFECTIVENESS OF TOURNAMENTS.

W. A. Glenn; *Virginia Polytechnic Institute*

Round robin, replicated knock-out, and double elimination tournaments (in which players are eliminated after two losses) are investigated for their effectiveness in selecting the best one of four players. The criteria proposed for the comparison are (a) the probability that the best player wins (after play-off if necessary) and (b) the expected number of games required for the determination of a winner. For general values of the parameters which characterize the system expressions are derived for the evaluation of the criteria. Comparisons are then made on the basis of series of assigned parameter values. The possibility of extending this investigation to cases involving a larger number of players is discussed.

LIST OF MEMBERS

1958-1959

Note: Following are the types of membership in the Academy.

***Patrons, who contribute one thousand dollars or more to the Academy.

**Life Members, who contribute one hundred dollars or more to the Academy.

**Honorary Life Members (Elected by Council).

*Sustaining Members, who pay annual dues of ten dollars.

—Contributing Members, who pay annual dues of five dollars.

Regular Members, who pay annual dues of three dollars.

Student Members, who pay annual dues of two dollars. (restricted to college students only).

Note: Number following name designated section, or sections, to which member belongs; "C" following name indicates "Student Member;" "B" following name indicates "Business Member."

- | | |
|--|----------------------|
| 1. Agricultural Sciences | 7. Engineering |
| 2. Astronomy, Mathematics, and Physics | 8. Geology |
| 3. Bacteriology | 9. Medical Sciences |
| 4. Biology | 10. Psychology |
| 5. Chemistry | 11. Science Teachers |
| 6. Education | 12. Statistics |

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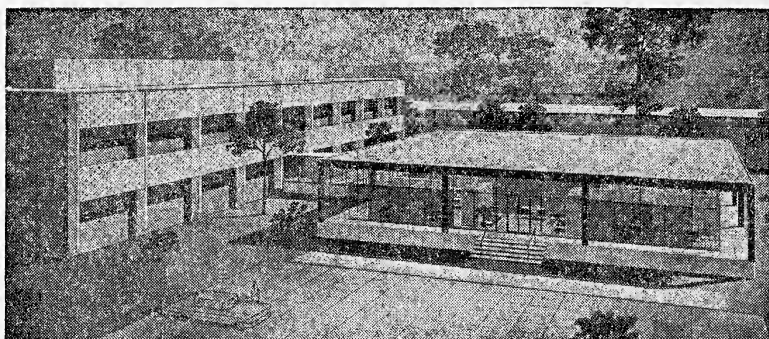
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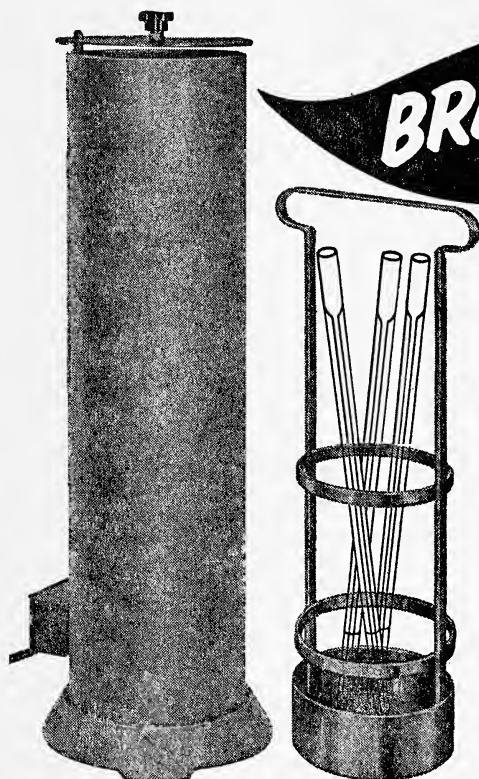
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C O N T E N T S

Pages

A Note on the Oxygen and Temperature Tolerances of the Triclad <i>Phagocata gracilis</i> (Haldeman) and <i>Dugesia</i> <i>tigrina</i> (Girard). Betty J. Abbott	1
Ground Vegetation Patterns of the Spruce-Fir Area of the Great Smoky Mountains National Park. Dorothy L. Crandall	9
A Study of Some Soil-Inhabiting Phycomycetes from Haiti. William W. Scott	19
Experimental Infections of Chick Embryos with <i>Tetrahymena</i> <i>pyriformis</i> . Jesse C. Thompson, Lynne Santy and Valer Clark	25
A Study of the Chlorophyta of the James River Basin, Virginia. II Ecology. B. R. Woodson	27
News and Notes	37

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THE VIRGINIA JOURNAL OF SCIENCE

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No. 1

A NOTE ON THE OXYGEN AND TEMPERATURE TOLERANCES OF THE TRICLADS *PHAGOCATA* *GRACILIS* (HALDEMAN) AND *DUGESIA* *TIGRINA* (GIRARD)

BETTY J. ABBOTT

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Studies of the relationship between physiological variation in animals, such as the work by Prosser (1955), have shown the importance of such variation in the problems of adaptation and distribution. It has been the purpose of this investigation to attempt to determine the oxygen and temperature tolerances of populations of two species of the triclad family Planariidae, *Phagocata gracilis* (Haldeman) and *Dugesia tigrina* (Girard). A treatment of the broader aspects of their ecology and evolution has not been attempted here. However, it is hoped that the results of this study will be of interest to the students of adaptation in this group.

Respiration in the triclads is undoubtedly of the ordinary aerobic type (Hyman, 1951b). According to Lund (1921) and Hyman (1929, 1951b) the rate of oxygen consumption of the *Dugesia* species is constant at different oxygen concentrations in the water until the concentration falls below about one-third saturation. Hyman (1929) reported that several species of planaria can live in oxygen concentrations as low as 0.4cc/liter and concludes that planaria are more or less independent of oxygen concentration.

In any attempt to determine the toleration of planaria to low levels of oxygen concentrations, consideration must be given to the effect of carbon dioxide. According to Anderson (1927), the accumulation of carbon dioxide does not effect the results of oxygen tolerance tests. Hyman (1925) stated that both low oxygen and carbon dioxide concentrations are of importance in affecting the rate of respiration, but that neither are controlling factors.

Perhaps the classic example of acclimation among planaria is seen in the stenothermous European forms *Dugesia gonocephala*, *Polycelis felina*,

and *Crenobia alpina* which occur along streams with increasing altitude and decreasing temperature in the order named (Hyman, 1951b). However, according to Hyman (1951b), most fresh water forms are eurythermous, that is, they are indifferent to a relatively wide change of temperature.

Most of the publications dealing with temperature studies are concerned with temperature as it affects oxygen consumption. Behre (1918), in studies of acclimation of planaria to rise in temperature, concluded that acclimation consists of changes which manifest themselves physiologically as a gradual decrease in the rate of metabolism or oxidation which enables them to be highly adapted to temperature acclimation. According to Hyman (1951b), planarians react to a temperature change of 20° to 30°C from that at which they have been living and Mast (1903) has shown that, when placed in a temperature gradient, *Dugesia dorotocephala* which had been living at a temperature of 22°C aggregated in a zone ranging from 17° to 26°C. Eddy and Gleim (1932) found that *Phagocata gracilis* aggregated at 0° to 10°C regardless of whether they were taken from their natural habitat at 9.5°C or kept for a month in the laboratory at 20° to 22° C. The thermal death point of *Phagocata gracilis* was found by these authors to be 30°C.

In view of the evidence presented in work previously done, which is related to temperature and oxygen tolerances, further study seems indicated that might show more clearly comparisons and differences between planaria found in widely different habitats. It was with this in mind that the present study was undertaken.

METHODS

Specimens of *Phagocata gracilis* used in this study were taken from the Heath Spring in Radford, Virginia, a location from which Kenk (1935) collected specimens of the same species. The spring has a sandy bottom, contains considerable *Spirogyra* sp., and periodic temperature checks made for the past year (1958) indicated that the temperature varied from 9° to 11°C. The pH of the water averaged 5.77, as determined by three tests made at different times. Oxygen content in three tests was 4.7 ppm, 4.4 ppm and 4.1 ppm, averaging 4.4 ppm. *Dugesia tigrina* specimens were taken from Strouble's Creek draining the "Duckpond" located on the V.P.I. campus in Blacksburg, Virginia. The stream bed here is rocky, with some clay and sand. It shows some evidence of pollution. The average pH was found to be 8.25, and the dissolved oxygen content of the water in three tests was 11.5 ppm, 11.9 ppm, and 11.1 ppm, showing an average oxygen content of 11.5 ppm. Stream temperatures were found to vary from 8° to 24°C during the year.

Identification of species used was made by the author and was based

upon serial sections as well as external characteristics. The specimens were compared with descriptions offered by Kenk (1935) and Hyman (1937, 1951a).

In determining tolerances to low oxygen concentrations, specimens were placed in 125 ml of water (taken from the stream in which the animals were collected and de-oxygenated by bubbling nitrogen through it) which was introduced into a mason jar of one pint capacity under a heavy layer of mineral oil. After introducing the water and the specimens, the jar was completely filled with mineral oil to prevent the entrance of oxygen, sealed, and returned to constant temperature storage in the laboratory. Oxygen concentrations present in all tests were determined by the Winkler method. Tolerance to increased temperature was determined by placing the specimens individually in 3 ml tubes which in turn were placed in a rheostat controlled water bath. The temperature was increased at the rate of 0.2°C every five minutes from 20°C (which was the temperature at which both species were kept for approximately 24 hours before the temperature and oxygen tests — this is in accord with the work of Eddy and Gleim, 1932, in their temperature toleration experiments and with the work of Hyman, 1925, in her oxygen consumption tests) until all specimens showed no response to stimuli and were therefore assumed to be dead. Specimens were “double checked” as to whether or not they were dead by returning them to laboratory storage for twenty-four hours to see if any revived. None did. Four tests were run for each species, with thirty specimens tested each time. All specimens were checked every five minutes, and the dead were recorded and removed from the water bath. Constant temperature tolerances were determined by placing the planaria in 400 ml beakers containing 300 ml of water. In both types of temperature tolerance tests the specimens were placed in water from their original habitat which was aerated just before using to prevent oxygen deficiency. These beakers were placed in the water bath and constant temperature maintained. Constant temperature tests for each species were begun at the “LD-50” level or mean lethal temperature of each species as determined by their tolerance to slowly increased temperature. Specimens were checked hourly until all were dead, or inactive for twenty-four hours.

RESULTS

There appears to be a marked difference in the oxygen requirements of *Dugesia tigrina* and *Phagocata gracilis*. In three tests involving 120 specimens of *Phagocata gracilis*, the amount of dissolved oxygen remaining in the water after the specimens were dead was 0.23 ppm, 0.52 ppm, and 0.39 ppm, which averaged 0.38 ppm. Three experiments with the same number of *Dugesia tigrina* disclosed rather high amounts of dissolved oxygen remaining in the water, 1.21 ppm, 1.37 ppm, 1.13 ppm for an average

of 1.23 ppm. In view of other work which has been done (Hyman, etc., previously cited) this seemed rather high and replicates were made of these experiments. Here the amount of dissolved oxygen remaining in the water was 1.34 ppm, 1.67 ppm, and 1.18 ppm, for an average of 1.24 ppm (Table 1).

A significant difference exists between the temperature tolerances of *Dugesia tigrina* and *Phagocata gracilis* as revealed by the experiments in which the temperature was raised slowly. With *Dugesia tigrina* the temperature range in °C was from 35.5 to 39.4, the mean was 37.7°, standard deviation 0.79, and the standard error of the mean 0.07. In the case of *Phagocata gracilis*, the temperature range in °C was from 30.5 to 34.9, the mean was 33.3, standard deviation 0.68, and standard error of the mean 0.06. Applying the "T" test, the difference is significant beyond the 0.01 level (Table 2).

Exposure to constant temperatures indicate that the highest temperature possible for survival of *Dugesia tigrina* lies below 34.7°C and is apparently around 33.7°C. The survival temperature for *Phagocata gracilis* is between 30.3°C and 29.3°C (Table 3.).

TABLE 1

Dissolved oxygen present in water after death of planaria
(40 planaria used for each test)

	Heath Spring (<i>Phagocata gracilis</i>)	Duckpond (<i>Dugesia tigrina</i>)	Duckpond Replicates
Test No. 1	0.23 ppm	1.21 ppm	1.34 ppm
Test No. 2	0.52 ppm	1.37 ppm	1.67 ppm
Test No. 3	0.39 ppm	1.13 ppm	1.18 ppm
Average	0.38 ppm	1.23 ppm	1.24 ppm

TABLE 2

Mortality of *Dugesia tigrina* and *Phagocata gracilis* when the temperature was raised at the rate of 0.2°C every five minutes.

<i>Dugesia tigrina</i>		<i>Phagocata gracilis</i>	
$^{\circ}\text{C}$	Number Dead	$^{\circ}\text{C}$	Number Dead
39.0 - 39.4	1	34.5 - 34.9	2
38.5 - 38.9	22	34.0 - 34.4	29
38.0 - 38.4	34	33.5 - 33.9	34
37.5 - 37.9	25	33.0 - 33.4	28
37.0 - 37.4	18	32.5 - 32.9	14
36.5 - 36.9	9	32.0 - 32.4	5
36.0 - 36.4	8	31.5 - 31.9	3
35.5 - 35.9	3	31.0 - 31.4	3
		30.5 - 30.9	2
Total	120	Total	120
Mean (M)	37.70	Mean (M)	33.30
Standard Deviation	0.79	Standard Deviation	0.68
Standard Error of M	0.07	Standard Error of M	0.06

TABLE 3

Results of constant temperature tests showing the mortality of
Dugesia tigrina and *Phagocata gracilis*
 according to hourly checks.

Temp. °C.	Hours															Total	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15-24	Dead	Alive
	Dugesia tigrina																
37.7	41	60	29													120	0
36.7	2	41	58	19												120	0
35.7	0	3	54	25	4	2	1									120	0
34.7	0	0	0	0	0	0	0	1	3	7	31	44	20	14		120	0
33.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120
	Phagocata gracilis																
33.3	21	41	27	20	11											120	0
32.3	1	23	56	44	10	6										120	0
31.3	0	0	0	0	1	1	11	34	41	23	7					120	0
30.3	0	0	0	0	0	3	9	17	24	35	15	0	0	0	0	103	17
29.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120

DISCUSSION

There is an apparent species difference in the oxygen requirements of the two species studied. However, in view of the fact that the high oxygen concentration in the water (ave. 11.5 ppm) was so near the saturation point, it is believed that the oxygen requirements of *Dugesia tigrina* (ave. 1.23 ppm remaining at death) may result in part from acclimation to high amounts of dissolved oxygen in the water. It is noted that in the case of *Phagocata gracilis*, where the average oxygen content of the water was 4.4 ppm, only an average of 0.36 ppm of oxygen remained in the water after oxygen toleration tests. It is not felt that the pH of the water was a factor in influencing oxygen requirements since the work of Hyman (1925) and Anderson (1927) indicated that a pH between 5.0 and 9.5 does not

affect the rate of oxygen consumption. This point might be worthy of further study.

Both species were collected at a time when the water in their respective habitats was at a temperature of 10°C. Eddy and Gleim (1932) have shown that laboratory storage at 20° does not affect lethal temperature and it is felt that this is borne out by this study. The difference in the lethal temperature of *Phagocata gracilis* as reported by Eddy and Gleim (1932) and that found in this study is due to intraspecific variation. However, other factors such as differences in method, temperatures tested, or length of the experiment may be partially responsible for the difference noted. Morphological variations in this species were remarked upon by Hyman (1937) after comparing Kenk's (1935) description of animals from Heath's Spring with specimens from other localities. Further morphological study is indicated which should include more comprehensive information regarding the Heath Spring specimens of *Phagocata gracilis*.

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LITERATURE CITED

- Anderson, Louise. 1927. The effects of alkalies on the oxygen consumption and susceptibility of *Planaria dorotocephala*. *Biol. Bull.* 53: 327-342.
- Behre, Ellinor. 1918. An experimental study of acclimation to temperature in *Planaria dorotocephala*. *Biol. Bull.* 35: 277-317.
- Buchanan, J. W. 1931. Modification of the rate of oxygen consumption by changes in oxygen concentration in solutions of different osmotic pressure. *Biol. Bull.* 60: 309-326.
- Eddy, M. W. and D. L. Gleim. 1932. A thermotropic gradient apparatus with some preliminary studies on *Phagocata gracilis*, *Triturus viridescens*, and *Lumbricus terrestris*. *Proc. Penn. Acad. Sci.* Vol. 6.
- Hyman, L. H. 1925. Action of acids on oxygen consumption. *Biol. Bull.* 49: 288-322.

- 1929. Effect of oxygen tension on oxygen consumption in *Planaria*. *Physiol. Zool.* 2: 505-534.
- 1937. Studies on the morphology, taxonomy, and distribution of North American triclad Turbellaria. VII. *Trans. Amer. Micros. Soc.* 56: 298-310.
- 1951a. Synopsis of the known species of fresh-water planarians of North America. *Ibid.* 70: 154-167.
- 1951b. *The invertebrates: Platyhelminthes and Rhynchocoela*. Vol. 2. McGraw-Hill Book Co. New York. pp 52-458. Figs. 13-173.
- Kenk, R. 1935. Studies on Virginia Triclad. *Jour. Elisha Mitchell Soc.* 51: 79-126.
- Lund, E. J. 1921. Oxygen concentration as a limiting factor in the respiratory metabolism of *Planaria agilis*. *Biol. Bull.* 41: 203-220.
- Mast, S. O. 1903. Reactions to temperature changes in freshwater planarians. *Amer. Jour. Physiol.* 10.
- Prosser, C. L. 1955. Physiological variation in animals. *Biol. Rev.* 30: 229-262.

GROUND VEGETATION PATTERNS OF THE SPRUCE-FIR AREA OF THE GREAT SMOKY MOUNTAINS NATIONAL PARK¹

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Although the spruce-fir area of the Southern Appalachians has interested several investigators, there have been few studies of the herbaceous plants in relation to the canopy and none with this relationship as the primary objective. Because the forest-site concept has never been specifically applied to the Southern Appalachian coniferous forests, an intensive study of the spruce-fir areas in the Great Smoky Mountains National Park was made with particular emphasis on the herbaceous and shrubby plant cover.

The Committee on Forest Terminology of the Society of American Foresters (1944) defines site as "An area considered as to its capacity to produce forests or other vegetation, the combination of biotic, climatic and soil conditions." This corresponds to the term habitat as used by many ecologists. In characterizing and classifying forest sites different investigators have used either characteristics of the forest stand itself or environmental factors. Many of these attempts have used a single factor such as moisture, land form or chemical soil analysis, but no single criterion can in itself adequately describe a site since the site type depends upon the interaction of all the edaphic, climatic and biotic factors.

Since a plant responds to the conditions about it, it is in a sense, a measure of its environment. Thus the plants of any given community reflect the interaction of the many environmental factors and these individual plants or plant communities have been used as indicators of habitat or site. Because of the greater number of species involved and because of the more rapid response to changes in their surroundings, herbaceous plants have been more frequently used than woody shrubs and trees as indicators of site. Individual plant species have been valuable in the West, but in general a plant community or group of plants will provide a more complete and satisfactory basis for an estimate of the environment.

One of the first to develop a system of forest site types based upon ground cover vegetation was the Finnish forester, A. K. Cajander (1926,

¹This paper is a portion of an article published in *Ecological Monographs*, 28:337-360, October, 1958.

1949). The use of ground vegetation in distinguishing forest site types in North America has been attempted by several investigators. These studies have included various coniferous forests in Western United States and Canada. Possible site types for the Southern Appalachians are included in R. H. Whittaker's 1956 report on *Vegetation of the Great Smoky Mountains* in which he lists 5 subtypes for spruce forests and 4 subtypes for fir forests. Using site counts and general estimation of coverage, Whittaker correlates site types with a series of topographic subtypes.

The specific areas selected for this study have been within accessible regions of the spruce-fir area in the Great Smoky Mountains National Park. These include samples from Mt. Le Conte, Mt. Sterling, Spruce Mountain and within an area extending from 10 miles northeast of Newfound Gap to the southernmost limit of spruce and fir in the Park, about 5 miles west of Clingmans Dome.

During the summers of 1951, 1953, 1955, and 1956, field data were collected in the following manner. A 50-meter rope marked off in 5-meter intervals was laid out twice in a "T" pattern, with one line across the slope and the other at right angles to the first. Herbaceous species were recorded for each 5-meter interval of a strip 1-meter wide and for each one meter section of the first 5-meters of the first strip. Coverage for herbaceous plants, including mosses, was recorded as percentage of line covered, using decimeter units following the sampling method employed in the Holly Shelter Wildlife Management Area by Wells (1946). For shrubs, numbers and heights were tabulated for each 5-meter interval of the meter wide strip giving a total area of 100 square meters. In this strip, seedlings and small trees were simply recorded as present if less than 6 inches high, and those at least 6 inches high up to 1 inch d.b.h. were tallied by numbers and heights.

Canopy and understory trees 1 inch d.b.h. and over were recorded by species and measured diameters. In 50 of the samples a strip 10-meters wide along the two 50-meter lines was employed while in 20 of the samples the strip was 5-meters wide. In 9 samples only one strip 50-meters long by 10-meters wide was used because of difficulty of terrain or in some cases because the particular spruce-fir community was not extensive enough to include a second sample at right angles to the first.

Notes on slope, exposure, elevation and general description were recorded for each sample. A few heights were recorded by means of the Abney level, but because of the density of the canopy and irregularities of the terrain this was exceedingly difficult. Estimates of heights were employed in the latter cases.

Although the number of tree species involved in the southern boreal forest is low and the canopy layer is floristically simple, much greater

variation is found in the lower strata and these differences in undergrowth patterns are the basis for the site types that have been designated. In many instances the boundary line between two adjacent site types is sharp but in others there is a recognizable ecotonal or transitional area between the two.

Most of these coniferous forests in the Smokies are mixtures of fir and spruce, but with increase in altitude there is a corresponding increase in fir and nearly pure fir forests occur at elevations above 6400 feet. The fir in the Park is Fraser fir, *Abies fraseri*, and the spruce is red spruce, *Picea rubens*. Fraser fir is endemic to the Southern Appalachians while the red spruce has a much wider range occurring as far north as Maine and Nova Scotia. Oosting and Billings (1951), in comparing the northern and southern spruce-fir forests of the Appalachians, concluded that these two forests are part of the boreal forest formation but with two distinct phases, the red spruce-Fraser fir and the red spruce-balsam fir.

At the higher altitudes the most frequent deciduous tree in the coniferous forests is the mountain ash, *Pyrus americana*, while abundant yellow birch *Betula alleghaniensis*, is found at the middle and lower elevations. Occasional beech, *Fagus grandifolia*, hemlock, *Tsuga canadensis*, yellow buckeye, *Aesculus octandra*, and sugar maple, *Acer saccharum* may be encountered at the lower spruce-fir elevations.

Eight site types and one subtype based upon differences in the undergrowth patterns have been designated for these forests. The occurrence of these site types under the various forest types are summarized in Table 1.

The Oxalis-Hylocomium site type, characterized by high coverage of feather mosses, occurs on steep northerly slopes at very high elevations or on somewhat more moderate slopes or nearly level areas at mid-elevations. Above 6000 feet the dominant tree is Fraser fir while at moderate altitudes red spruce becomes the codominant canopy tree. On both these fir and spruce-fir sites there are many stems, generally of small diameters, rather straight and tall with a considerable number of standing dead stems, especially fir in the 1-4 inch diameter classes. Mountain ash is an occasional canopy tree on the fir sites and yellow birch is more frequently encountered on the spruce-fir sites. Considerable fir reproduction may occur on the more level area in the lower altitude mixed forest. Similar species of herbaceous plants are found on the two sites, chiefly *Aster acuminatus*, *Clintonia borealis* and the two ferns *Dryopteris spinulosa* v. *americana* and *Athyrium filix-femina*. The forest floor is wet with seeping water or mountain springs and the substratum is rocky, typically of loose slabs of slate which are covered with luxuriant mosses and give a hummocky appearance to the lower strata. These mosses, which are designated

feather mosses in this paper, may consist of nearly 100 per cent *Hylocomium splendens*, *Hypnum crista-castrensis* and *Hylocomium umbratum*. Much of the debris from fallen trees is wet, rotten and covered with filmy mosses and liverworts. Windthrow may be particularly disastrous in the fir stands at the higher elevations resulting in extensive even-aged stands. These are probably the stands described by Cain in 1931 as stagnant pole stands, since there may be many stems rather closely spaced and frequently many of these in the same diameter class.

The *Oxalis-Dryopteris* fir site type may be observed in the very high elevation forests on Mt. Le Conte and Clingmans Dome. The slopes are usually slight or moderate and exposure may be in any direction. The moss layer ranges from low in coverage to very high on the more moist sites where the fern coverage is less. The latter type may approach the *Oxalis-Hylocomium* type just described. In those instances where the fern coverage is nearly 100 per cent, the moss and *Oxalis* layers are considerably reduced. The most common herbaceous plants occurring with the ferns are *Aster acuminatus*, *Solidago glomerata*, *Clintonia borealis*, *Stachys clingmanii* and *Chelone lyoni*. *Trillium erectum*, *Angelica triquinata*, *Streptopus roseus*, *Impatiens pallida* and patches of *Houstonia serpyllifolia* may be found. Shrubs few in number, may include *Vaccinium erythrocarpum*, *Menziesia pilosa*, *Sambucus pubens* and occasionally *Virburnum alni-folium*. *Abies fraseri* frequently attains 95 per cent or more of the basal area. The firs are branchy, much moss covered, and frequently dripping with moisture from the enveloping clouds. The trees appear stunted, measuring from 35-50 feet in height and are somewhat distantly spaced giving a parklike or open woods appearance to these forests. *Pyrus americana* and *Picea rubens* are occasionally present.

The *Hylocomium-Vaccinium* site type occurs in both the spruce-fir and the spruce forests on steep or precipitous slopes. Feather mosses form a treacherous mat over the underlying rocks and fallen timber rotten and moist may be criss-crossed over these rocks and this too is overlain with a deep moss layer. The characteristic herbs in the fir forest include *Aster acuminatus*, *Clintonia borealis*, *Solidago glomerata* and *Senecio rugelia*. Frequently fir reproduction is high, solid patches of one to two-foot seedlings occurring in openings created by the death or fall of canopy trees. The total coverage of herbs exclusive of *Oxalis montana* and ferns is usually under 15 per cent and there may be a continuous low shrub stratum of *Vaccinium erythrocarpum*. Canopy trees are not large in diameter and in the understory there are many stems both living and dead in the small diameter classes.

The *Virburnum-Vaccinium-Dryopteris* site type occurs in fir, spruce-fir and spruce forests. These forests show a characteristic five-storied development in the undergrowth layers, moss-*Oxalis*-fern-*Vaccinium*-*Virbur-*

num. The fir sites generally have a higher coverage of moss and *Oxalis* compared to those of lower altitudes in the spruce-fir and spruce forests. Much of the moss in the fir site type is *Hylacomium splendens*, while this species may be absent on the spruce site. This site type supports the best developed stands of the mixed spruce-fir forest type.

Excellent examples of the *Senecio* site type may be observed in the vicinity of Clingmans Dome on steep slopes, generally of southwest or northwest exposure. *Oxalis montana* and ferns are low in coverage, but *Senecio rugelia* may cover nearly 100 per cent of the ground. The bryophytic layer is sparse and mosses and liverworts are of several species with little *Hylacomium splendens* in the mixture. Frequently as the surface becomes more level, especially near the top of the ridges, there may be a perceptible increase in coverage of fern and *Solidago glomerata*. The canopy trees are chiefly *Abies fraseri* of relatively small diameter.

The *Viburnum-Vaccinium-Senecio* site type occurs on steeper and drier sites than the *Viburnum-Vaccinium-Dryopteris* site type. Exposures are generally west, northwest or southwest. Moss, *Oxalis* and fern coverages are low in this site type and *Senecio rugelia* may be of moderately high coverage with usually some ground covered only by needles and dry litter. Spruce trees of very large diameters are encountered on this and the following type.

The *Viburnum-Vaccinium-Lycopodium* site type is the most prevalent site type in the spruce forests of the Great Smoky Mountains National Park. Much of the ground is bare of plants and covered with needles and fallen debris, the latter only partially encrusted with thin filmy mosses and liverworts. The high percentage of needle cover distinguishes this site type from the slightly more moist *Viburnum-Vaccinium-Senecio* type under spruce-fir. *Lycopodium lucidulum* and *Medeola virginiana* are frequently conspicuous and are good indicators of this type. *Senecio rugelia*, ferns and mosses may be present in the pockets and depressions but total coverage of ground plants is lowest of any site type. Shrubs are frequently only scattered. The spruce trees are of relatively large diameter and the total basal area may be high.

The *Rhododendron* site type extends throughout the southern boreal forest. At high elevations under a canopy of fir the most important shrubs are *Rhododendron carolinianum* and *R. catawbiense* with *Menziesia pilosa* and *Diervilla sessilifolia* in the more open area. The ground cover varies from nearly zero on the more exposed ridges and crags to nearly 100 percent *Hylacomium splendens*, *Sphagnum* sp. and other mosses on the steep wet north slopes. At lower elevations spruce becomes the dominant canopy tree and *Rhododendron maximum* and *Kalmia latifolia* with perhaps *Leucothoe editorum* and *Smilax rotundifolium*, become increas-

ingly important. Adjacent to the dry heath balds the ground cover consists of only an extremely low coverage of lichens and mosses with an occasional specimen of *Trillium undulatum*, *Galax aphylla*, *Lycopodium clavatum* or *L. obscurum*. Here the spruce and fir trees are taller and of larger diameter. With increasing amounts of *Viburnum* in the tall shrub layer, yellow birch becomes a more important tree and the fern and herb coverages are greater. Where there is a mixture of *R. maximum*, *R. catawbiense* and *Viburnum alnifolium* in the tall shrub layer this type may approach the *Viburnum-Vaccinium-Dryopteris* site type. It is this type that has been designated as the *Rhododendron* (*Viburnum*) subtype. The spruce trees on this type are frequently of large diameters and more than 100 feet in height. In addition to spruce, yellow birch is usually an important canopy tree.

TABLE I

OUTLINE OF SITE TYPES OF THE SPRUCE-FIR AREA OF THE
GREAT SMOKY MOUNTAINS NATIONAL PARK

Fir Forests (6200-6600 Feet)	Spruce-Fir Forests (5500-6400 Feet)	Spruce Forests (5100-6000 Feet)
Oxalis-Hylocomium	Oxalis-Hylocomium	
Oxalis-Dryopteris		
	Hylocomium- Vaccinium	Hylocomium- Vaccinium
Viburnum-Vaccinium-Dryopteris	Viburnum- Vaccinium-Dryopteris	Viburnum- Vaccinium-Dryopteris
Senecio	Viburnum- Vaccinium-Senecio	
		Viburnum- Vaccinium- Lycopodium
Rhododendron	Rhododendron	Rhododendron
	Rhododendron (Viburnum)	Rhododendron (Viburnum)

SUMMARY

Forest-site types and various interrelationships of the upper and lower strata of the spruce-fir forests of the Great Smoky Mountains National Park are discussed. Based upon frequency and coverage of species of shrubs and herbaceous plants, the eight site types proposed for the southern boreal forest are as follows:

1. *Oxalis-Hylocomium*
2. *Oxalis-Dryopteris*
3. *Hylocomium-Vaccinium*
4. *Viburnum-Vaccinium-Dryopteris*
5. *Senecio*
6. *Viburnum-Vaccinium-Senecio*
7. *Viburnum-Vaccinium-Lycopodium*
8. *Rhododendron*

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APPENDIX

SPECIES CHARACTERISTIC OF SPRUCE-FIR FORESTS

Canopy Trees

Abies fraseri (Pursh) Poir.
Amelanchier laevis Weig.
Betula alleghaniensis Britton
Fagus grandifolia Ehrh.
Picea rubens Sarg.
Prunus pensylvanica L.
Pyrus americana (Marsh.) DC.

Understory Trees

Acer pensylvanicum L.
Acer spicatum Lam.
Cornus alternifolia L.
Ilex montana T. and G.

Shrubs

Diervilla sessilifolia Buckl.
Hydrangea arborescens L.
Kalmia latifolia L.
Lonicera canadensis Bartr.
Menziesia pilosa (Michx.) Juss.
Pieris floribunda (Pursh) B. and H.
Pyrus melanocarpa (Michx.) Willd.
Rhododendron carolinianum Rehder
Rhododendron catawbiense Michx.
Rhododendron maximum L.
Ribes rotundifolium Michx.
Rubus canadensis L.
Sambucus pubens Michx.
Smilax rotundifolia L.
Vaccinium simulatum Small
Vaccinium erythrocarpum Michx.
Viburnum alnifolium Marsh.
Viburnum cassinoides L.

Herbaceous Flowering Plants

Agrostis alba L.
Angelica triquinata Michx.
Arisaema atrorubens (Ait.) Blume
Aster acuminatus Michx.
Aster divaricatus L.
Cardamine clematitis Shuttlw.
Carex brunnescens (Pers.) Poir
Carex debilis var. *rudgei* Bailey
Carex intumescens var. *fernaldii* Bailey
Cheloni lyoni Pursh
Chimaphila maculata (L.) Pursh
Cimicifuga racemosa (L.) Nutt.
Cinna latifolia (Trev.) Griseb.
Circaea alpina L.
Claytonia virginica L.
Clintonia borealis (Ait.) Raf.
Danthonia spicata (L.) Beauv.
Dioscorea villosa L.
Eupatorium rugosum var. *roanense* (Small) Fern.
Galax aphylla L.
Houstonia serpyllifolia Michx.
Impatiens pallida Nutt.

Laportea canadensis (L.) Wedd.
Luzula acuminata Raf.
Luzula bulbosa (Wood) Rydb.
Maianthemum canadense Desf.
Medeola virginiana L.
Mitchella repens L.
Monotropa uniflora L.
Oxalis montana Raf.
Saxifraga micranthidifolia (Haw.) Britt.
Senecio rugelia A. Gray
Smilacina racemosa (L.) Desf.
Smilax herbacea L.
Solidago glomerata Michx.
Stachys clingmanii Small
Strephopus roseus Michx.
Trillium erectum L.
Trillium undulatum Willd.
Viola pallens (Banks) Brainerd
Viola rotundifolia Michx.

Ferns and Club Mosses

Athyrium filix-femina (L.) Roth
Dennstaedtia punctilobula (Michx.) Moore
Dryopteris spinulosa var. *americana* (Fishch.) Fern.
Lycopodium clavatum L.
Lycopodium lucidulum Michx.
Lycopodium obscurum L.
Polypodium virginianum L.

LITERATURE CITED

- Cain, S. A. 1931. Ecological studies of the vegetation of the Great Smoky Mountains of North Carolina and Tennessee. *Bot. Gaz.* 91: 22-41.
- Cajander, A. K. 1926. The theory of forest types. *Acta Forest Fenn.* 29: 1-106.
- . 1949. Forest types and their significance. *Acta Forest Fenn.* 56: 1-71.
- Oosting, H. J. & W. D. Billings. 1951. A comparison of virgin spruce-fir forest in the northern and southern Appalachian system. *Ecology* 32: 84-103.
- Society of American Foresters. 1944. Forest terminology. A glossary of

technical terms used in forestry. Society Amer. Foresters, Washington, D. C.

Wells, B. W. 1946. Vegetation of Holly Shelter Wildlife Management Area. N. C. Dept. Cons. & Developm. Bull. 2: 1-40.

Whittaker, R. H. 1956. Vegetation of the Great Smoky Mountains. Ecol. Monog. 26: 1-80.

A STUDY OF SOME SOIL-INHABITING PHYCOMYCETES FROM HAITI

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Although the phanerogamic flora of Haiti is relatively well known, little attention has been devoted to the fungi, particularly to the aquatic and terrestrial phycomycetous taxa. During the summer of 1958, Dr. K. W. King, of the V. P. I. Biology Department, visited this area as a member of a nutritional survey team organized by the Research Corporation and the Institute of Nutrition Sciences, Columbia University. Supported by a research grant from the Virginia Academy of Science, Dr. King collected and returned to this laboratory samples of cultivated field soils and virgin soils from each of the major climatic and geographical areas of Haiti. Collection sites are indicated on the map illustrated in Figure I.

The methods of collection and isolation were essentially those described by Sparrow (1943) and Raper (1937). Pure culture techniques followed closely those described by Johnson (1956). In the following list of fungi identified citations for specific binomials are given, but synonyms are not listed. For synonymous taxa, reference is made to Coker and Matthews (1937), Sparrow (1943), Johnson (1956), and Gilman (1957). All collection sites are shown on the accompanying map (fig. 1).

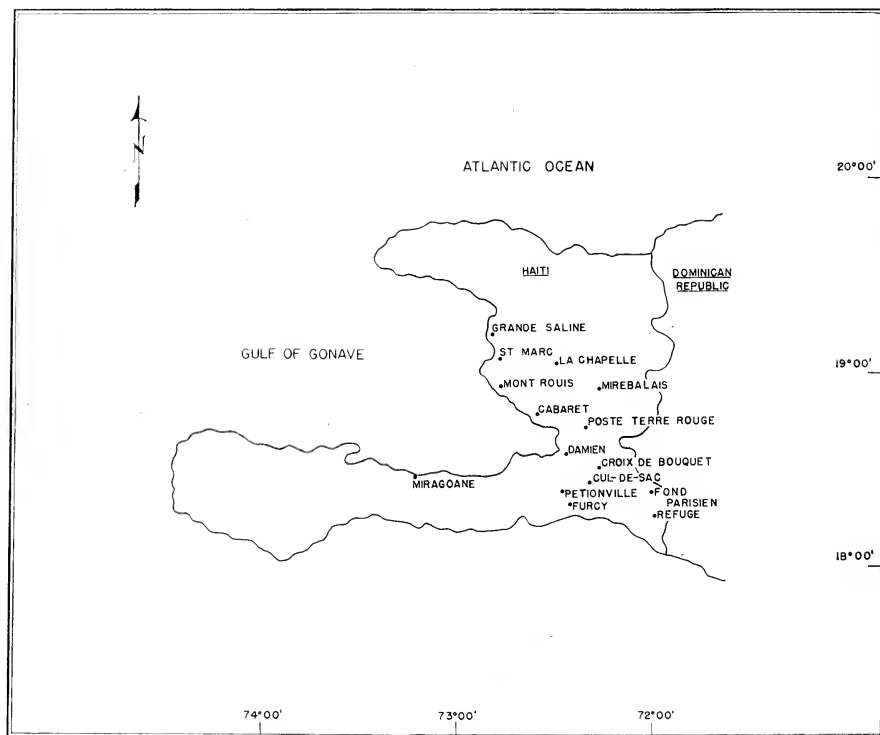
FUNGI COLLECTED

Chytridiales

Rhizophlyctis rosea (deBary and Woronin) Fischer, Rabenhorst Kryptogamen — Fl., 1: 122. 1892. *R. rosea* was encountered in almost every sample examined. It appeared exclusively on cellophane and grass baits from all sites except 4, 7, 15 and 19. Among the isolates observed, the size and shape of the sporangium, the number of discharge papillae, and the nature of the rhizoidal system varied to a considerable degree. No tendencies toward lobulate sporangia or toward a polycentric type of thallus were noted. The color of the sporangial contents varied from orange to golden brown. The presence of endoopercula was not observed. All isolates as described above may be included in the broad concept of this species. Further study may reveal, however, that the numerous isolates now recognized under the binomial *R. rosea* may represent a complex of several taxa. The designation of such a complex as a single taxonomic entity is arguable.

Rhizophlyctis spp. A number of distinct monocentric chytrids were

Fig. 1. Sketch of the Haitian Republic showing collection sites.



Cabaret	Site 5	Moragoane	Site 19
Cul-de-Sac	Site 1, 6, 10	Mirebalais	Site 21
Croix de Bouquet	Site 3	Mont Rouis	Site 4, 15
Damien	Site 12	Petionville	Site 7
Fond Parisien	Site 17, 22	Poste Terre Rouge	Site 8
Furcy	Site 14, 16, 18	Refuge	Site 9, 20
Grande Saline	Site 13	St. Marc	Site 11
LaChapelle	Site 2		

observed on grass and snake skin baits (sites 1, 2, 3, 11, 14, 16, 18, and 21). Although probably related to *Rhizophlyctis*, positive identification was impossible since the amount of material was limited or, in a number of cases, the forms were incompletely observed.

Cladochytrium replicatum Karling, Amer. Jour. Bot., 18: 538. 1931. This polycentric chytrid was observed once on grass bait from a soil sample collected near Cabaret (site 5). The Haitian isolate differed in no way from previously described isolates. It is apparently wide spread in its distribution, appearing frequently in soils as a saprophyte on vegetable debris.

Blastocladales

Allomyces anomalus Emerson, Lloydia, 4: 133. 1941. A single isolate representing the genus *Allomyces* was obtained from soil collected in a fallow field near Fond Parisien (site 22). Since the sporophyte invariably produces RS zoospores which give rise to asexual plants, it is assumed that the sexual stage is omitted from the life-cycle. According to Emerson (1941), such isolates are assigned to the binomial *A. anomalus*.

Saprolegniales

Aphanomyces laevis deBary, Jahrb. wiss. Bot., 2: 179. 1860. *A. laevis* was observed twice on snake skin bait from laterite soil collected under grass near Furcy (site 16). Oogonia were formed in abundance and these were in no way different from previously described isolates.

Brevilegnia linearis Coker and Braxton, J. Elisha Mitchell Sci. Soc., 42: 214. 1927. This species was isolated twice from laterite soil in a pine forest near Refuge (site 9). *B. linearis* is distinguished from other members of the genus by the elongate sporangium containing spores in a single row.

Brevilegnia diclina Harvey, J. Elisha Mitchell Sci. Soc., 42: 243. 1927. A single isolate of *B. diclina* appeared in one of the collections from Refuge (site 20). This species differs from *B. linearis* and from *B. subclavata* by the elongate nature of the sporangium, the majority of which contain spores arranged in more than one row.

Dictyuchus sp. (H8). An interesting isolate of *Dictyuchus* was observed once from tropical-brown, fallow soil collected near Poste Terre Rouge (site 8). The oogonia appear similar to those of *D. monosporus* but are irregularly roughened. They measure 28-30 μ in diameter and contain single oospores, measuring 21-23 μ in diameter. The antheridia are declinuous and occur singly (rarely 2 per oogonium). In the Haitian isolate the sporangia are mostly of the true-net type. Less frequently, but not uncommon, are the false-net type of sporangia. Sometimes the entire sporangium breaks free to float away as in some species of *Brevilegnia*. Achlyoid

sporangia have not been observed. Further study may reveal this isolate to be a species distinct from those previously described.

Leptolegniella keratinophilum Huneycutt, J. Elisha Mitchell Sci., Soc., 68: 110. 1952. The highly characteristic sporangial stage of this fungus was observed in a number of collections (sites 6, 8, 14, 16) on snake skin bait. Thick-walled spores were observed, but rarely. No additional information can be added to the incompletely known life-cycle of this fungus.

Peronosporales

Pythium debaryanum Hesse, Inaugr. Dissert. Halle. 1874. The most frequently encountered member of the genus appearing in nine soil samples (collections made at sites 2, 4, 8, 9, 11, 14, 16, 18 and 22) was *P. debaryanum*. From those species producing non-proliferating spheroidal sporangia and smooth-walled, aplerotic oogonia, *P. debaryanum* may be distinguished by the presence of several antheridia, these being both monoclinalous and diclinalous. When monoclinalous the antheridia originate some distance from the oogonium, never adjacent to it.

Pythium ultimum Trow, Ann. Bot., 15: 269-312. 1901. A single isolate of *P. ultimum* was recovered from a soil sample collected under a cactus at Cul-de-Sac (site 10). It may be distinguished from *P. debaryanum* only in the consistent formation of monoclinalous antheridia originating closely adjacent to the oogonia. Differences in the thickness of the oospore wall were not apparent in the Haitian material. Furthermore, sporangial germination by zoospore formation was frequently observed in this material. Subsequent sub-cultures, however, produced sporangia germinating only by germ tube. The writer concurs with Van Luijk (1934) in the contention that the differences between *P. ultimum* and *P. debaryanum* are insufficient to warrant the retention of the former binomial as a distinct species.

Pythium vexans deBary, Jour. Bot., 14: 105-126. 1876. Two isolates of *P. vexans* were obtained from soils collected at Cul-de-Sac (sites 1 and 6). This species may be distinguished from other members possessing non-proliferating, spheroidal sporangia and smooth-walled, aplerotic oogonia by the characteristic antheridia. These are monoclinalous in origin, arising in close proximity to the oogonium. The shape of the antheridial cell was variable, not necessarily bell-shaped as stated by Middleton (1943).

Pythium undulatum Petersen, Bot. Tidssk., 29: 345-440, 1909; and *Pythium intermedium* deBary, Bot. Zeit., 39: 553-558. 1881. A total of five isolates of the spheroidal sporangial type were obtained which failed to form sexual stages under the cultural conditions (sites 3, 4, 10, 17 and 21). Since these isolates were examined periodically for a period of six months and since all methods for the induction of sex organs were unsuccessful, it is assumed that these isolates lack the ability to reproduce

sexually. Two of these isolates produced papillate, proliferating sporangia with sessile vesicles characteristic of *P. undulatum*. Another asexual isolate formed non-proliferating sporangia in a catenulate manner characteristic of *P. intermedium*. The additional asexual isolates lacked a distinguishing characteristic and were not identifiable.

Pythium mamillatum Meurs, Wortelrot, Verrorzaakt door Schimmels vit de Geslachten *Pythium* Pringsheim en *Aphanomyces* deBarry. 1928. A single isolate of *P. mamillatum* was obtained from alluvial soil collected under cacti at Fond Parisien (site 17). It is readily distinguished from other echinulate oogonial species by the plerotic oogonium and the relatively short conical, obtuse nature of the oogonial protuberances.

Pythium afertile Kanouse and Humphrey, Papers Mich. Acad., 8: 129-140. 1927. Three isolates of *Pythium* species bearing the filamentous type of sporangium and lacking the sexual stage were observed (sites 5, 12 and 20). As is customary, all such isolates may be cited under the binomial, *P. afertile*. The writer concurs with Middleton (1943) in recognizing the possible difficulties arising from the practice of assigning a binomial to an organism of this type. The binomial may be maintained as reference to a distinct species lacking a sexual stage or it may be regarded as including a variety of related species, the sexual stage being absent at the time of observation. Once the sexual stage is encountered, transference to another binomial would be mandatory.

Pythium catenulatum Matthews, Studies on the Genus *Pythium*. 1931. A single isolate of this species was obtained from tropical brown soil collected in a fallow field near Poste Terre Rouge (site 18). Typical irregularly inflated sporangial elements were observed in abundance. Oogonia were rarely formed. When observed, these were smooth-walled, plerotic, with several to many monoclincous and diclincous antheridia. As far as the writer can determine, this is the first report of *P. catenulatum* isolated from soil.

REFERENCES CITED

- Coker, W. C. and V. D. Matthews. 1937. North American Flora, 2: 1-76.
- Emerson, R. 1941. An Experimental study of the Life Cycles and Taxonomy of Allomyces. Lloydia, 4: 77-144.
- Gilman, J. C. 1957. A Manual of Soil Fungi. The Iowa State College Press, Ames, Iowa.
- Johnson, T. W. 1956. The Genus *Achlya*. The University of Michigan Press, Ann Arbor, Michigan.
- Middleton, J. T. 1943. The Taxonomy, Host Range, and Geographic

Distribution of the Genus *Pythium*. Mem. Torrey Bot. Club, 20: 1-171.

Raper, J. R. 1937. A Method of Freeing Fungi from Bacterial Contamination. Science, 85: 342.

Sparrow, F. K. 1943. Aquatic Phycomycetes. The University of Michigan Press, Ann Arbor, Michigan.

Van Luijk, A. 1934. Untersuchungen uber Krankheiten der Graser. Meded. Phytopath. Lab. Scholten, 13: 1-22.

EXPERIMENTAL INFECTIONS OF CHICK EMBRYOS WITH *TETRAHYMENA PYRIFORMIS*

Jesse C. Thompson, Jr., Lynne Santy, and Valet Clark, *Hollins College*

Thompson (1958), in experiments dealing with facultative parasitism in the protozoan genus *Tetrahymena*, was able to establish infections in 7-day-old chick embryos with strain WH-6 of *Tetrahymena pyriformis* (referred to as strain WH-1 in 1958 paper). This strain was able to infect the fluid contents of the egg and also penetrated into the circulatory system and general musculature of the living embryo.

The present investigation was undertaken to determine the susceptibility of various stages of chick embryonic development to infections with strain WH-6 of *T. pyriformis*.

Axenic cultures of strain WH-6 of *T. pyriformis* were inoculated into chick embryos at various stages of incubation (days 3, 5, 7, 9, 11, 13, 15, and 17). Twelve eggs of each stage were inoculated with a tuberculin syringe using a size 27 needle. Eggs were examined at daily intervals for six days after inoculations to determine infections.

Embryos in eggs inoculated at days 3 and 5 of incubation were alive after 24 hours but all were heavily infected and dead after 48 hours. Embryos of eggs inoculated at the 7th day of incubation were alive after 24 hours, but all except 4 were heavily infected and dead after 48 hours; these 4 were dead after 72 hours. All embryos of eggs inoculated at the 9th day of incubation became infected and were alive after 48 hours; five embryos were alive at 72 hours, two were alive at 96 hours but were dead at 120 hours. Eggs were candled through the 9th day of incubation to determine the condition (alive or dead) of the embryos. Embryos of eggs inoculated at the 11th day of incubation were alive when examined up to six days after inoculation. Ten of 12 eggs were infected. Embryos of eggs inoculated at the 13th day of incubation were alive when examined up to six days after inoculation. Eight embryos were not infected. One embryo examined late on the 19th day of incubation was found to harbor thousands of Protozoa in the yolk sac which at this time was found in the body cavity of the embryo but still remained a separate sac attached to the gut. All embryos except two in eggs inoculated at the 15th day of incubation were alive when examined. Four were not infected. One chick was examined 48 hours after hatching and thousands of Protozoa were found in the yolk sac which was still a separate part of the gut. All embryos except two inoculated at the 17th day of incubation were alive when examined. Two eggs did not hatch and

were not infected. Six embryos examined were alive but not infected. Four chicks were examined after hatching and one was found to contain a few Protozoa in the yolk sac.

The results of this experiment show that infections with strain WM-6 of *Tetrahymena pyriformis* occurred in all stages of inoculated chick embryos. Fatal infections were established in all eggs inoculated through the 9th day of incubation. It was observed that in these fatal infections the older the embryo at time of inoculation the longer it survived. Older embryos (11th through 17th day) seemed to survive infections quite well. Here it was also noted that the general tendency to resist infections increased with age of embryo.

Death of the embryos, particularly those at older stages (9th-17th day), was not caused by protozoan invasions of the embryo proper since sections of musculature of the body wall, liver, intestine, and caecum revealed no ciliates. Phase microscopical examination of the fluid contents of the eggs revealed no bacteria.

Strain WH-6 of *Tetrahymena pyriformis* was inoculated into developing chick embryos at various stages of embryonic development (days 3, 5, 7, 9, 11, 13, 15, and 17) to determine the most susceptible stages for infection. Younger embryos were more susceptible, but infections were established in all stages inoculated. One embryo carried the infection through embryonic development and the yolk sac contained Protozoa as long as 48 hours after hatching.

This investigation was supported by grants from the Virginia Academy of Science and the American Academy of Arts and Sciences.

LITERATURE CITED

- Thompson, J. C., Jr., 1958. Experimental infections of various animals with strains of the genus *Tetrahymena*. *J. Protozool.*, 5:203-205.

A STUDY OF THE CHLOROPHYTA OF THE JAMES RIVER BASIN, VIRGINIA

II. ECOLOGY¹

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The number of species of Chlorophyta (82) along with three species of Rhodophyta and four species of Chrysophyta (*Vaucheria*) seem quite poor for the area covered in this study. There are many factors, however, that might contribute to such a low number of species. It has been suggested that many forms may be missed in collections due to the fact that they may reach their climax and disappear before they can be collected; especially so if one is only making seasonal surveys as was done in this study. Another factor that may influence the number of species is rate of current. Many forms are unable to inhabit the swifter streams, becoming more or less planktonic as they mature; thus they are carried away by the currents if there are no other plants or debris with which they may become entangled. Many streams, because of the swiftness of the currents, therefore, are unfavorable for most planktonic forms as well as for many attached forms. The pH of the water may also determine what species will inhabit a particular stream. It has been suggested that pollution also may have an influence on the distribution of species.

The above mentioned factors are only a few of the possible numerous ones which may influence the number of different kinds of species that may inhabit a particular stream or streams of a particular locality. Table 1 lists 20 streams that are considered as possibly the main drainage points of the James River Basin. In this table the pH, hardness (CaCO_3 content), nitrogen (NO_3 content), pollution, and swiftness of the stream are considered. The number of genera found in each stream is divided into those that are considered planktonic and those that are normally attached or filamentous. On the basis of these data, a discussion follows on the possible influence of such factors on the number of species observed in this study.

HARDNESS AND pH OF THE WATER

It has been indicated that the acidity or alkalinity of a stream will influence the development of certain forms of algae; however, it has been observed that many forms will grow within a wide pH range. It is

¹This paper is Part II of a study. Part I was published in *Va. Jour. Sci.* Vol. 10, (n.s.): 70-82, April, 1959.

well to mention here that most streams will not reach a high acid condition similar to bogs or even other forms of lakes unless they are being polluted by mines or industrial wastes (Welch, 1952; Lackey, 1939; Conrad, 1942). Even in these instances, dilution plays an important part in that the greater the distance from the source of the pollution the less the concentration of the contaminating substance. It has been suggested by many phycologists that neutral or slightly alkaline conditions which appear to be characteristic of most temperate zone streams appear to be necessary for the growth of most of the algal species inhabiting flowing water (Blum, 1956; Welch, 1952). Examining the data in Table 1, it is observed that no direct correlation can be made as to the importance of pH on the number of species. Craig Creek has an average pH of 7.5 and eleven species, Catawba Creek on the other hand has a pH of 7.5, but only one species. Jackson River has a pH of 7.6, and its species number only two. Even though we do not see a positive correlation here, it has been observed by some phycologists (Foged, 1948; Hustedt, 1939; and Prescott, 1951) that alkaline waters have more species of plants than acid; at least this was found to be true for lakes and possibly could be true also for streams. However, pH becomes a controlling factor when water reaches very acid or very alkaline range. In this survey, the range was from 6.4-7.6. Ordinarily we expect the maximum growth rate within this range, other factors being favorable.

Hardness was analyzed on the basis of the total amount of calcium carbonate (CaCO_3) in water. There is a correlation between pH and hardness of water in that streams that are considered hard are usually alkaline, and those that are considered soft are usually acid; however, the amount of CaCO_3 may vary depending upon the degree of breakdown of this substance by organisms inhabiting the stream. Streams with less than 61 p.p.m. of CaCO_3 are considered soft and streams above 61 p.p.m. are considered hard. It has been suggested that slightly hard waters (alkaline) are more productive as to number of species than soft (acid) (Foged, 1948; Hustedt, 1939; Prescott, 1951). In this study it was found that streams a little on the acid side were more productive than those somewhat on the alkaline side. Maury River had a pH of 7.4 and hardness of 104 p.p.m., but only two species were found. The two species observed, however, were growing quite profusely, but at different times of the year; *Rhizoclonium hieroglyphicum* was collected in March and *Hydrodictyum reticulatum* was collected in August. Catawba Creek had a pH of 7.5 and a hardness of 154 p.p.m.; however, there was only one species observed. Jackson River had a pH of 7.6 and a hardness of 83 p.p.m., but only two species were observed. There seems to be a little inconsistency in the data on Craig Creek in that the pH (7.5) indicates a slightly alkaline condition but the hardness is quite low (43 p.p.m.). The forms of plants observed (*Chara*, *Elodea*, *Potamogeton*, etc.) are considered calciphilic forms. However, the fact

that much of the lime is taken out of the stream in metabolism and by becoming encrusted on the stalks of *Chara* and the other plants that were growing rather profusely, may explain the generally low concentration of CaCO_3 in the stream.

The streams that were slightly acid and/or soft were: Swift Creek which had a pH of 6.6 and a hardness of 12 p.p.m., with 12 species observed; Falling Creek had a pH of 6.5 and a hardness of 47 p.p.m., with four species observed; Chickahominy River had a pH of 6.4 and hardness of 49 p.p.m., with eight species observed; Fine Creek had a pH of 6.8 and a hardness of 15 p.p.m., with 11 species observed; however, Hardware River had a pH of 6.8 and a hardness of 15 p.p.m., but only one species was observed. The Appomattox River had a pH of 7.0 (neutral) and a hardness of 27 p.p.m., but 15 species were observed. Rivanna River was also neutral and had a hardness of 17 p.p.m., but only three species were observed. Even though the streams that were slightly acid seem to be more productive as to species number, there does not seem to be consistency in production as exemplified by the total number of soft-water streams. In other words, the factor of hardness is an important one in algal distribution, but apparently it is not the controlling factor. Possibly one can state that it is the interaction of other factors along with pH and/or hardness.

NITROGEN CONTENT OF THE STREAM

It has been suggested that nitrates are more abundant during the winter and spring months when streams are high and plant growth greatly reduced (Blum, 1953; Butcher, 1924; Kofoid, 1903; Pearsall, 1923; Wade, 1949). Such changes may be explained by the greater consumption of nitrates when plants are growing quite profusely (Prescott, 1951; Sawyer, 1944; Wade, 1949); thus tending to lower the total concentration of nitrates in the water chemistry. In this study the most productive streams had very low concentration of nitrates. To cite a few, Chickahominy River had 0.09 p.p.m., nitrates, but had 8 species observed; Swift Creek had 0.15 p.p.m. of nitrates, and 12 species observed; Fine Creek had 0.2 p.p.m. nitrates, and 11 species observed. However, there were some streams in this survey that had equally low nitrate content, but quite poor species distribution. Again to cite a few — Slate River had 0.23 p.p.m., but only one species; Hardware River with only 0.35 p.p.m., and one species observed; Rockfish River with 0.35 p.p.m., and only two species observed. It can be stated here, however, that none of the streams with more than 0.5 p.p.m. were very productive. Maury River had a nitrate content of 1.6 p.p.m., but only two species observed; Catawba Creek had 1.4 p.p.m. of nitrates and only one species, and Rivanna River had 0.7 p.p.m., nitrates, but only three species observed. Thus, it can be generalized from these results

that low nitrogen content may not enhance algal distribution, but increased algal growth may bring about a decrease in nitrogen content of a stream by utilization of the nitrate in metabolism (Prescott, 1951; Sawyer, 1944; Wade, 1949). Although pollution is to be considered later, it can be stated here that organic pollution may tend to increase the nitrogen content of a stream (Blum, 1956; Butcher, 1949; Brinkley, 1942; Lackey, 1942); therefore, Maury River with high nitrogen content seemed to be quite polluted also. Catawba Creek with the other high reading of 1.4 p.p.m. also seemed polluted and was quite turbid or muddy and had only one species observed.

STREAM POLLUTION

It has been stated by several aquatic biologists that many algal species can be utilized as indicators of pollution (Budde, 1928; Fjerdingsstad, 1950; Huet, 1949; Liebmann, 1942); however, no attempt has been made in this study to indicate which species of Chlorophyta is an indicator of pollution. In polluted streams the total number of species may be reduced, however, those that will grow are more than likely to be quite prolific (Brinkley, 1942; Butcher, 1940; Lackey, 1942). Many species of *Oscillatoria*, a blue green alga, may form dense mats in polluted streams. This was observed by the author in some of the streams that seemed polluted in this survey, such as the Maury River. This is a rather large slow-flowing stream, and very little algal growth was observed outside of the two species cited; but quite good growths of *Potamogeton crispus* and *Elodea canadensis* were observed. The Appomattox River is another rather large stream that seemed polluted from sewage; however, quite a few species were observed to be growing in or around the stream in the backwashes or quiet pools formed from overflow of the stream. Some of the streams in this survey that seemed polluted were almost devoid of algal forms and higher plants as well. Rockfish River is an example of such a stream; there were only two species of algae observed and no higher aquatic plants. Another example of such a stream is the Hardware River with only one species of algae and limited aquatic higher plants. The Jackson River is another polluted stream (although the pollution is due to waste from a papermill rather than sewage pollution) with very low algal population and limited aquatic higher plants. Thus, it can be concluded that pollution does tend to influence the number and kind of algal forms that will inhabit a particular stream.

RATE OF FLOW

It has been stated above that flowing water presents a hazard for the development of plants in general (Butcher, 1947; Cedergren, 1938).

Table 1. Summary of results in twenty streams

Streams	pH		CaCO ₃ ¹		NO ₃ ¹		Pollution		Rate of flow		Number of species	
	Below 7.2	Above 7.2	Low	High	Low	High	Yes	No	Slow	Fast	P ²	A ²
Craig Creek		7.5	43		0.2			—		X	7	4
Beaverdam Creek		7.1	19		0.24			—	X		3	0
Swift Creek	6.6		12		0.15		+			X	10	2
Appomattox River	7.0		27		0.35		+		X		5	10
Rivanna River	7.0		17		0.7			—			0	3
Maury River		7.4		104		1.6	+		X	X	0	3
Catawba Creek		7.5		154		1.4	+		X		0	1
Falling Creek	6.5		47		0.13		+			X	1	3
Pedar River	6.9		13		0.2			—		X	0	2
Deep Creek	6.8		26		0.16			—	X		5	0
Rockfish River	6.8		12		0.35		+			X	2	0
Buffalo Creek		7.2	24		0.25		+			X	1	1
Hardware River	6.8		15		0.35		+			X	0	1
Chickahominy River	6.4		49		0.09			—			4	4
Cowpasture River		7.4		61	0.26					X	0	2
Slate River		7.2	19		0.23		+			X	0	1
Willis River	6.9		26		0.2		+		X		5	0
Jackson River		7.6		83	0.3		+				0	2
Fine Creek	6.8		15		0.2			—	X	X	7	4

1. CaCO₃ and NO₃ determinations were made by the Department of Conservation, Division of Water Resources of Virginia

2. P — Planktonic; A — Attached

The swifter streams are usually devoid of higher aquatic plants, and only a few filamentous algal species are able to survive the rapids. *Cladophora* has been cited as one genus that does very well in the swifter streams (Blum, 1953). In general, however, the slower streams are more productive as to number of species that can become established. The possible reasons for such variation in the two types of streams — slow vs. fast — have been given by several phycologists in discussion of stream ecology (Butcher, 1946, Blum, 1956; Neel, 1951; Guimaraes, 1930); however, one can readily see the hazard involved in such a habitat. Many plankton forms, because of their habit of growth, are unable to populate swifter streams (Abdin, 1948; Allen, 1920; Cilleuls, 1926; Fritsch, 1905). Since these streams are usually poor for higher aquatics and in many instances quite poor for filamentous forms of algae, the plankton are carried down stream much more rapidly than they can reproduce or repopulate any particular portion of the stream (Allen, 1920; Kofoid, 1903, 1908; P-van Oye, 1926; Galtsoff, 1924). In the slower streams, all things being equal, these plankton forms are trapped between the higher aquatic plants and also between the filaments of the attached algal forms; thus they are able to increase their number.

In this survey it was observed that the swifter streams were a little less productive as far as numbers of species than the slower. There are a few exceptions that should be cited here. Maury River was quite slow, yet it had only two species observed; however, the stream was quite hard, muddy, and polluted which may account for the small number of forms. Craig Creek was fairly swift, however, 11 species were observed. It also can be noted here that the planktonic forms of this stream outnumber the filamentous, but mention has been made above of the fact that this stream was very well populated by *Chara*, *Elodea*, *Potamogeton*, etc., which served as traps for these plankters; these aquatics were growing in the quieter portions of the stream. The Appomattox River, also a slow stream, had twice as many filamentous algae as plankters. On the other hand, Fine Creek, also a slow stream, had more plankters than filamentous species. Chickahominy River, which is also a slow stream, had as many plankters as filamentous forms. Even though no great difference can be observed here in the productiveness of a stream as to plankton or filamentous forms being affected by current rate, it can be observed that those streams that were poor for aquatics were also quite poor for plankters. Slate River had no aquatics and no plankters; however, it did have a very good growth of *Spirogyra*. The Hardware River was another poor stream for aquatics, and no plankters were observed either; however, there was a very fair growth of *Rhizoclonium*. The Jackson River was very poor for aquatics also, but had a rich growth of *Spirogyra*; however, no plankters were observed. Of course it should be mentioned here that most of the plankters considered in this survey are desmids, and these forms

are considered calciphobic (acid-loving); however, there are exceptions to every rule, for a few desmids, i.e. *Closterium moniliferum* and *C. tumidum*, will thrive just as well in a slightly alkaline habitat as in an acid one.

Summary

In summarizing the results of this survey, several observations can be made.

1. The number of species of Chlorophyta inhabiting the tributaries of the James River Basin is quite low.
2. The pH of these streams range from 6.4-7.6. Within this range, it is quite difficult to determine the influence of pH on the number of species; however, the streams that had the largest number of species were slightly on the acid side of the pH scale. It has been suggested that the pH exerts its greatest influence when quite low on the acid side or quite high on the alkaline side of the scale.
3. Streams that were slightly soft or low in CaCO_3 content had the greatest number of species; however, on the basis of hardness alone it is quite difficult to determine the direct influence of this one factor on the distribution of species in this study. Rather, it is thought that other factors interacting with hardness tend to influence the distribution.
4. The nitrogen content of a stream does influence the distribution of species; however, the low content of nitrogen in a stream may be influenced by the volume of growth in a stream. When growth rate is low, then nitrogen-content may be high.
5. Pollution may be a factor limiting the number and kinds of species that will inhabit a particular stream. Organic pollution may tend to increase the nitrogen-content of a stream; therefore, acting as a fertilizing factor. The streams in this study that seemed polluted were quite poor for numbers of species; however, those forms that were able to survive were quite prolific in their growth.
6. The swifter streams in this survey had fewer species than the slower. There were a few exceptions in that two or more of the slower streams were not especially productive, but this was thought to be due to other factors as pollution, hardness, pH, turbidity, etc. In general the swifter streams were almost devoid of both algae and higher aquatic plants, but those that could survive the hazard of swift currents usually thrived very well.

LITERATURE CITED

- Abdin, G. 1948. Physical and chemical investigations relating to algal growth in the River Nile, Cairo. Bull. Inst. Egypt 29: 19-44.
- Allen, W. E. 1920. A quantitative and statistical study of the plankton of the San Joaquin River. Univ. Cal. Publ. Zool., 22: 1-292. Pl. 1-12.
- Blum, J. L. 1953. The ecology of algae growing in the Saline River, Michigan, with special reference to water pollution. Doc. Thesis, Univ. Mich., ix + 176 pp.
- 1956. The ecology of River Algae. Bot. Review. Vol. 22. No. 5.
- Brinkley, F. J. 1942. The effect of the sewage from Nashville upon the plankton population of the Cumberland River. Jour. Tenn. Acad. Sci., 17: 179-183.
- Budde, H. 1928. Die Algenflora des Sauerlandischen Gebirgsbaches. Arch. Hydrobiol., 19: 433-520.
- Butcher, R. W. 1924. The plankton of the River Wharfe. (Yorkshire) Naturalist, 1924: 175-180; 211-214.
- 1940. Studies in the ecology of rivers, IV. Observations on the growth and distribution of the sessile algae in the River Hull, Yorkshire. Jour. Ecol., 20: 210-223.
- 1946. Studies in the ecology of rivers, VI. Algal growth in certain highly calcareous streams. *Ibid.*, 33: 268-283.
- 1947. Studies in the ecology of rivers. VII. The algae of organically enriched waters. *Ibid.*, 35: 186-191.
- 1949. Problems of distribution of sessile algae in running water. Vohr. Int. Ver. Theoret. Ang. Lim., 10: 98-103.
- Cedergren, G. R. 1938. Reofila eller det rinnande vattnets algeamhallen. Svensk. Bot. Tidskr., 32: 362-373.
- Cilleuls, J. Des. 1926. Le Phytoplancton de la Loire. Compt. Rend. Acad. Sci. (Paris) 182: 649-651.
- Conrad, W. 1942. Sur la faune et la flore d'un ruisseau de l'Ardenne Belge. Mem. Mus. Roy. Hist. Nat. Belg., I, 99: 1-177. Pls. 1, 2.
- Farlow, V. 1928. Algae of ponds from intestines of tadpoles. Biol. Bull. 55: 443-448.

- Fjerdingstad, E. 1950. The microflora of the River Mollena with special reference to the relation of the benthal algae to pollution. *Fol. Limnol. Scandivav.* No. 5. 123 pp. 1. pl.
- Foged, N. 1948. Diatome in water courses in Funen. IV-VI. Danks, Bot. Ark. 12 (9): 1-58 + 2 pp., *Ibid.* (12): 1-110.
- Forest, H. S. 1954. Checklist of algae in the vicinity of Mt. Lake Biol. Station, Va. *Castanea.* 19: 88-104.
- Fritsch, F. E. 1905. Algological notes. VI. The plankton of some English rivers. *Ann. Bot.* 19: 163-167.
- Galtsoff, P. S. 1924. Limnological observations in the upper Mississippi. U. S. Bur. Fish., Bull. 39: 347-483.
- Guimaraes, J. R. A. 1930. Consideracoes sobre a capacidade biogenica das aguas. *Rev. Indust. Animal (Sao Paulo)*, I: 508-514.
- Huet, M. 1949. La Pollution des Eaux. L'analyses biologique des eaux polluees. *Trav., Stat. Recherches Groenendael. Tr. D. Bull. Centre Belge d'Etude et de Documentation des Eaux*, No. 5, 6. 31 pp.
- Hustedt, F. 1939. Diatomeen aus den Pyrenaen. *Ber. Duet. Bot. Ges.*, 56: 543-572.
- Kofoid, C. A. 1903. The plankton of the Illinois River, 1894-1899, with introductory note upon the hydrography of the Illinois River and its basin. Part I, Quantitative investigations and general results. *Bull. Ill. State Lab. Nat. Hist.*, 6: 95-629. Pl. 1-50.
- . 1908. The plankton of the Illinois River, 1894-1899, with introductory notes upon the hydrography of the Illinois River and its basin. Part II, Constituent organisms and their seasonal distribution. *Bull. Ill. State lab. Nat. Hist.*, 8 i-vii, 1-355. Pl. 1-5.
- Lackey, J. B. 1939. Aquatic life in waters polluted by acid mine waste. (U.S.A.) *Public Health Rep.*, 4: 740-746.
- . 1942a. The effects of distillery wastes and waters on the miscropic flora and fauna of a small creek. (U.S.A.) *Public Health rep.*
- . 1942b. The plankton algae and protozoa of two Tennessee rivers. *Amer. Midl. Nat.*, 27: 191-202.
- Liebmann, H. 1942. Uber don Einfluss der Verkrautung auf den Selbstreinigungsvorgang in der Salle unterhalb Hof. *Vom Wasser*, 14: 92-108.

- Meyer, S. L. 1940. Genus *Phacus*. Dujardin. Virginia Jour. Sci. 1 (5): 117-118.
- Neel, J. K. 1951. Interrelations of certain physical and chemical features in a head water limestone stream. Ecology, 32: 368-391.
- Oye, P. van. 1926. Le Potamoplancton du Ruki au Congobelge et des pays chaude en general. Int. Rev. Ges. Hyrobiol. Hydrogr, 16: 1-50.
- Pearsall, W. H. 1923. A theory of diatom periodicity. Jour. Ecol. 11: 165-183.
- Prescott, G. W. 1951. Algae of the Western Great Lakes Region, Cranbrook Press.
- Sawyer, C. W. 1944. Investigation of odor nuisance occuring in Madison Lakes particularly Lakes Monona, Waubessa, and Kegonsa from July 1942 to July 1943. Mimeographed Report.
- Strickland, J. C. 1940. The Oscillatoriaceae of Virginia. Amer. Jour. Bot., 27 (8): 628-633.
- Wade, W. 1949. Some notes on the algal ecology of a Michigan Lake. Hydrobiologia, 2 (2): 109-117.
- Welch, P. S. 1952. Limnology. 2 ed. xi, 558 pp.

NEWS AND NOTES

(Editor's Note: — News contributions should be sent to the person whose name appears at the end of the appropriate sections.)

MESSAGE FROM THE PRESIDENT

The thirty-eighth annual meeting of the Virginia Academy of Science will be held in Richmond on May 11-14, 1960 with the Jefferson Hotel as headquarters. It is appropriate that the University Center in Virginia, whose cooperation with the Academy made possible the securing of a grant from the National Science Foundation to support our Visiting Scientists Program, should serve as sponsor for the meeting.

The Council and all section chairmen join me in urging Virginia Scientists to report on their research and to encourage their students to "try their wings" with papers. Attention is called to the fact that a member submitting a paper can also enter it in competition for the J. Shelton Horsley award. In addition to your Section Meeting, plan to attend and participate in the business meeting and the Academy Conference. The guest speaker for the Friday night meeting will be Dr. Harry F. Harlow, Professor of Psychology at the University of Wisconsin. A past president of the American Psychological Association and Editor of the Journal of Comparative and Physiological Psychology, Professor Harlow has the rare ability to present sound scientific findings in a fascinating manner.

Your Academy is dedicated to the development of the scientific potential of the youth of the state. May I urge all Senior Scientists to cooperate in every possible way with the Junior Academy and to visit its exhibits. You will be well rewarded in addition to giving encouragement to the scientists of tomorrow.

The local Committee on Arrangements under the Chairmanship of Mr. William D. Greshman, Jr., Assistant Administrator of the University Center in Virginia, with the cooperation of scientists in the Richmond area, will provide all the facilities necessary for a successful meeting. Your attendance and participation will assure its success.

William M. Hinton, *President*

MINUTES OF THE COUNCIL MEETING

NEWCOMB HALL, UNIVERSITY OF VIRGINIA, October 24, 1959

President Hinton presided with the following Council members, Committee Chairmen, and Section Representatives present:

Council: Wilson B. Bell, Robert T. Brumfield, John C. Forbes, William G. Guy, Horton H. Hobbs, George W. Jeffers, Harry G. M. Jopson, Charles F. Lane, Paul M. Patterson, Robert C. Yates; William T. Gresham, from University Center, Richmond (Local Arrangements); W. W. Scott, (Junior Academy of Science), Jackson J. Taylor (Research); James T. Calven (Geology), J. F. Hahn (Psychology), Jesse C. Thompson (Biology).

The minutes of the meetings of Council and Academy May 7-9 were read and approved.

Note was taken of the placement of the subcommittee on Education on the Long-Range Committee (See minutes of May 9, 1959) and Jesse Thompson led a discussion probing methods as to how the Academy may aid in improvement of secondary school science instruction.

Jackson Taylor gave a financial report of the Research Committee. He reported requests were slow to come in and questioned adequate publicity concerning these funds. It was recommended that Section Chairmen publicize this. The Editor of the Journal had, in past years, notified Section Chairmen of deadlines concerning abstracts and the Research Committee Chairman notified them of the Horsley Award. It was recommended that the President write the Section Chairmen a letter concerning all deadlines.

W. W. Scott reported that the Junior Academy members were active over the summer and the Committee had had their fall meeting. For the Visiting Scientists Program, John C. Forbes reported that of those invited, 14 had accepted to visit Virginia colleges. They have been divided between 26 colleges with two institutions, as a rule, sharing one person for a week. He pointed out that applications to the National Science Foundation would have to be made at an early date if we wished to try this program a second year. After some discussion Roscoe Jackson moved that such an application be made for next year to N.S.F. The motion was seconded and passed.

President Hinton read the pro tem. financial report Foley Smith had mailed to him. He then called attention to the fact that the Teacher-Sponsor Scholarships at the University of Virginia and the College of William and Mary were not filled by appointees nor alternates. It was suggested that several alternates be named.

Dr. Hobbs reported the Committee to nominate an Editor and Business Manager for the Virginia Journal of Science (see minutes of Council meeting of May 9, 1959). The slate consisted of Robert Ross as Editor and Robert Kral as Business Manager. He moved their appointment and the motion passed.

Dr. Brumfield said review articles for the Journal were hard to get and pointed out several aspects of their importance. He further called attention to the rising costs of printing, thus making the Journal unable to pay its own way. Furthermore, surplus funds were rapidly being used up. Discussion arose as to the ways of increasing the Journal's income. President Hinton reported that he would appoint a committee to study this.

Dr. Scott sought permission for obtaining a speaker for the Junior Academy whose evening program would be over by 8:00 p.m. Thursday so as not to conflict with the senior annual Academy Conference on May 12, 1960. Dr. Hobbs moved that permission be granted and the motion was passed. Dr. Scott suggested some move be made to improve the visitation of senior scientists to the Junior Exhibits.

Dr. Forbes moved that if the Finance Committee finds it feasible, the Secretary, as well as the Treasurer, be given expenses to attend AAAS meetings when they are held east of the Mississippi River. The motion passed.

President Hinton announced that the next meeting would be held in the spring in Richmond.

The meeting adjourned.

Paul M. Patterson, *Secretary*

RETIREMENTS

LINWOOD H. WARWICK. Geological Survey Assistant with the Division of Mineral Resources, Department of Conservation and Economic Development, Charlottesville, Virginia, retired after fifty years and nine months of service. It is thought that Warwick may hold the record for continuous employment at one office among geologists in this country. He began his career with the Division of Mineral Resources on October 8, 1908 as a stenographer when he was an undergraduate at the University of Virginia. He remained there until his retirement on June 30, 1959. When he began his work, he and Dr. Thomas L. Watson, State Geologist, comprised the entire staff at the Division of Mineral Resources. There are now twenty-two persons employed there headed by Dr. James L. Calver.

Linwood Warwick was born June 14, 1887. He is the son of the late John H. and Martha Rebecca Mann Warwick, lifelong residents of Charlottesville. He graduated from the old Midway High School and later was awarded the degree of bachelor of science from the University of Virginia. On October 3, 1936 he married the former Miss Mary Elizabeth Hatcher of Lynchburg. They have no children. They live at 113 Observatory Road, in Charlottesville.

Warwick is a charter member of the Thomas Jefferson Chapter, Sons of the American Revolution, serving some time as secretary-treasurer to the chapter. He is a life member of the Jamestown Society. His church affiliation is with the Christ Episcopal Church, where he once sang in the choir.

His hobbies include genealogy, music and theatricals. It is his boast that he is the only male alumnus of St. Anne's School for girls, where he studied voice. As a High School student he wrote poetry, some of which was published in the Charlottesville *Daily Progress*. At seventy-two he remains a keen student and a man of varied interests.

ARTHUR BALLARD MASSEY, Professor of Biology at Virginia Polytechnic Institute retired June 30, 1959. He was born January 10, 1889. He is the son of the late W. F. Massey and Aurilla J. Phoebus Massey. In 1913 he married the former Modd M. Miller (deceased) by whom he had a son, James W. Massey. In 1951 he married the former Violet B. Lockwood.

Mr. Massey received the Bachelor of Science degree from North Carolina State College in 1909, and the Master of Science degree from Virginia Polytechnic Institute in 1928. In 1956 he was awarded the degree of Doctor of Science from Lynchburg College, Lynchburg, Virginia. He taught at Clemson University from 1910 to 1913 and at Alabama Polytechnic Institute from 1913 to 1918, where he held the rank of Assistant Professor. He joined the faculty at Virginia Polytechnic Institute in 1918 and rose to the rank of Professor.

In 1915 he was nominated Fellow of the American Association of Sciences, and in 1958 he was the recipient of the Wine Award at Virginia Polytechnic Institute. He is a member of Sigma Xi, Phi Sigma, the Botanical Society of America, the Southern Appalachian Botanical Club and the Virginia Academy of Science. Since 1935 he served as Chairman of the Academy's Flora Committee. He has published several bulletins through the Virginia Agricultural Experiment Station.

Throughout his long and distinguished career as a "pansy picker" he has brought together a herbarium at Virginia Polytechnic Institute of from 25,000 to 30,000 sheets. The bulk of this collection was gathered by

Dr. Massey and represents the largest herbarium of the flora of Virginia in the Commonwealth. The herbarium also contains materials from the Gulf and Atlantic coasts north to New York State. Of special interest are some of Ravenal's sheets collected in South Carolina in 1875.

Since retirement Mr. Massey may be found actively at work in the herbarium. Every so often he may be found afield in knee boots, jophurs, jacket, hat, pipe and with loaded vascula beside him. He does not seem to take retirement too seriously.

AGRICULTURAL SCIENCE SECTION

Miss Beth Jordan, Professor of Home Economics Education in the Department of Vocational Education at Virginia Polytechnic Institute, has been granted a 6 month leave of absence to do advanced work at Ohio State University. Miss Jordan succeeded Professor Martha Creighton who retired on October 1, 1959.

Dr. T. J. Horne presented a progress report of the National Young Farmer Study at the annual convention of the American Vocational Association in Chicago. Dr. Horne, Head of Agricultural Education in the Virginia Polytechnic Institute Department of Vocational Education, is chairman of the association's national committee on research in agriculture.

Dr. R. W. Engel, Head of the Department of Biochemistry and Nutrition at Virginia Polytechnic Institute recently returned from a tour of duty as a consultant for the Department of Health Education Service. Duties took him to the Philippines, Japan, Formosa, Vietnam, Rome and Geneva.

Dr. M. S. Read has accepted a temporary appointment to replace Dr. K. W. King who is serving in Haiti for Columbia University while on leave-of-absence from Virginia Polytechnic Institute. Dr. Read comes to Virginia Polytechnic Institute from the Army Medical Nutrition Research Laboratory, Denver, Colorado, where he was in charge of contract programs at academic institutions and in private research laboratories for the Office of the Surgeon in connection with wholesomeness testing of foods sterilized by ionizing radiation. During his appointment, Dr. Read will offer a special course in the technology, biochemistry, bacteriology and nutritional aspects of food irradiation.

Dr. G. C. Graf has been elected president of the Virginia Polytechnic Institute Chapter of the AAUP. Dr. Graf is Head of the Department of Dairy Science.

Professor P. M. Reaves, Professor of Dairy Science, Virginia Polytechnic Institute, recently attended the meeting of the American Feed Manu-

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facturers Association. He is a member of this group's Feed Survey Committee which reviews the feed supply and demand in the United States.

The following members of the staff of the Department of Dairy Science at Virginia Polytechnic Institute will present papers at the Association of Southern Agricultural Workers meeting in February: Dr. W. K. Stone, Dr. V. L. Baldwin, Dr. M. F. Ellmore and Professor W. S. Griffith. Dr. G. C. Graf, Head of the Department is a member of the auditing committee of the ASAW and a director of the Southern Division of the American Dairy Science Association

Mr. W. L. Beane has been appointed Assistant Professor of Poultry Husbandry at Virginia Polytechnic Institute. Mr. Beane, who received his M.S. from the University of Maine, will work primarily in the field of poultry management.

Dr. A. T. Leighton, Jr., has been appointed Associate Professor of Poultry Husbandry at Virginia Polytechnic Institute. He received his M.S. from the University of Massachusetts and his Ph.D. from the University of Minnesota. Dr. Leighton will conduct research in turkey genetics and physiology.

Mr. A. N. Huff, returns to Virginia Polytechnic Institute in January as Livestock Extension Specialist. He has been on leave while serving in the Army. Mr. C. R. Cooper, former Livestock Extension Specialist, has been changed to Instructor in Animal Husbandry teaching and research.

Dr. R. F. Kelly, Mr. P. Graham and Dr. J. P. Fontenot of Virginia Polytechnic Institute's Animal Husbandry Department recently presented papers at the annual meeting of the American Society of Animal Production in Chicago.

Paul B. Siegel, *Virginia Polytechnic Institute*

BIOLOGY SECTION

Mr. Robert Kral was appointed Associate Professor of Biology at Virginia Polytechnic Institute to fill the vacancy created by Mr. A. B. Massey's retirement June 30, 1959. Mr. Kral received the B.F. degree from North Carolina State University in 1952 and the Ph.D. degree from Florida State University in 1952. Mr. Kral is now serving as Manager for the Virginia Journal of Science.

Mr. Henry S. Mosby, Mr. Byrd S. McGinnis and Mr. Robert D. Ross and graduate students of Virginia Polytechnic Institute attended the joint meetings of the Southeastern Section of the Wildlife Society and the Southeastern Association of Game and Fish Commissioners at Baltimore,

Maryland, September 21-25, 1959.

Mr. Henry S. Mosby of Virginia Polytechnic Institute is editing a "Manual of Game Investigations Techniques." The manual is now approximately 75% in proof. When ready for distribution it will fill an urgent need for a comprehensive treatise on wildlife techniques.

Mr. William W. Scott of the Department of Biology, Virginia Polytechnic Institute, attended the Summer Institute for College Botany Teachers at Indiana University, Bloomington, Indiana, from June 20 to August 20, 1959. The Institute was sponsored by the National Science Foundation. On January 15, 1960, Mr. Scott plans to go to the University of Wisconsin, Madison, Wisconsin, where he will serve as Visiting Professor of Botany. He expects to return to Virginia Polytechnic Institute June 10, 1960.

The Flue Cured Tobacco Variety Evaluation Committee met at Blacksburg November 30-December 1, 1959. Mr. H. E. Hegstad, of the United States Department of Agriculture, Beltsville, Maryland was appointed Chairman and Mr. M. J. Rogers, Superintendant of the Chatham Bright Tobacco Research Station was elected Secretary of the Committee for 1960.

Mr. Samuel A. Wingard, General Chairman, and Mr. George M. Shear, Secretary of the Horticulture Section, attended the Cumberland Shenandoah Fruit Worker's Conference at Hagerstown, Maryland November 19-20, 1959. Mr. Shear recently prepared Leaflet 448 "Growing Watercress" for the United States Department of Agriculture.

Mr. James M. Grayson and Mr. Donald G. Cochran of the Department of Entomology at Virginia Polytechnic Institute, attended the joint meetings of the Entomological Society of Ontario, the Entomological Society of Canada and the Entomological Society of America at Detroit, Michigan, November 30 to December 3, 1959. Mr. Grayson gave two papers: "Laboratory selection of the German cockroach for resistance to Malathion and Diazinon," and "Resistance to DDT and Chlordane in the German cockroach following discontinuance and restoration of selection." Mr. Cochran gave a paper: "Nucleotide dephosphorylation of sarcosomes from the American cockroach."

Mr. Dietrick H. F. A. Bodenstein has been appointed Chairman of The Department of Biology at the University of Virginia, and is expected to assume his new duties about February 1, 1960. Mr. Bodenstein, an insect physiologist, comes from the Gerontology Department of the Baltimore City Hospital. He was elected to the National Academy of Sciences in 1958. Mr. Horton H. Hobbs, Jr., has recently been serving as Acting Chairman of the department.

Mr. Smritimoy Bose, for several years a Research Fellow of The Blandy Experimental Farm — after receiving his Ph.D. at the University of Virginia in 1959, has accepted a temporary appointment as Assistant Professor of Horticulture, Purdue University.

The following have been among recent out-of-state scientific visitors at The Blandy Experimental Farm — Amar Nath Khanna (Government Agricultural College, Kanpur, India); Remedios J. Fernandez (of the Philippines); Seleh Idris (Bogur Botanical Garden, Java, Indonesia); A. E. Brandt (University of Florida); B. Obesfanks (University of Pisa, Italy); T. S. Osborne (University of Tennessee-A.E.C. Laboratory); Sydney Cross Harland (University of Manchester, England); Charles W. Rick, (University of California, Davis).

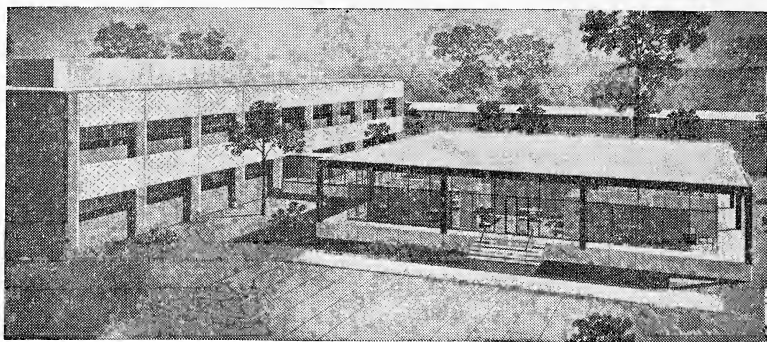
Walter S. Flory, Jr., *University of Virginia*

ENGINEERING SECTION

Professor Fred W. Bull of the Chemical Engineering Department at Virginia Polytechnic Institute presided at the regional meeting of the Industrial and Engineering Chemistry Division of the American Chemical Society held November 6 in Richmond. N. F. Murphy, F. W. Bull, P. W. Ruggieri, Jr., and R. C. Hart presented a paper on "Decolorization of Caustic Wash Liquors from Chlorine-Bleached, Sulfate, Wood Pulp." Professor N. F. Murphy and Dr. Arthur Doumas have been awarded U. S. Patent No. 2,902,416 on a "Method and Bath for Electrodeposition of Aluminum." In November Dr. Murphy spoke to the Hartford, Connecticut Branch of the American Electroplaters' Society on the subject of "Metal Electrodeposition from Non-Aqueous Systems."

Dean Lawrence R. Quarles of the School of Engineering at the University of Virginia attended a meeting as a member of the Board of Directors of the American Nuclear Society in Gatlinburg, Tennessee in June. He is chairman of the Educational Sub-Committee of this Society. He also attended the annual meeting of the American Society for Engineering Education in Pittsburg as a member of the Executive Committee of the Engineering Colleges Administrative Council. In November Dr. Quarles attended a meeting of this Council in St. Louis, Missouri. Dean Quarles has been appointed by Governor Almond to the State Nuclear Advisory Committee and in November, as a representative of the State, he attended a meeting of the Regional Advisory Council on Nuclear Energy in Nashville, Tennessee. Dean Quarles was invited to present a lecture on "Nuclear Energy in the South" at Southwestern at Memphis in November.

Mr. Tilton E. Shelburne, Director of the Virginia Council for Highway Investigation and Research, at the University of Virginia, and Professor R.



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E. Lee Gildea of the Civil Engineering Department attended the annual meeting of the American Society of Civil Engineers in Washington in October. Mr. Shelburne is a Director for Division Six of this Society. In November Mr. Shelburne attended the Bureau of Public Roads Construction and Maintenance Conference and spoke to this group on the work on Skid Prevention done by the Council.

Professor J. Lawrence Meem of the Nuclear Engineering Department at the University of Virginia attended the National Meeting of the American Nuclear Society in Washington in November. He is a member of the Student Branches and Local Chapters Committee. At that time he also met with the sub-committee on Research Reactors of the National Research Council.

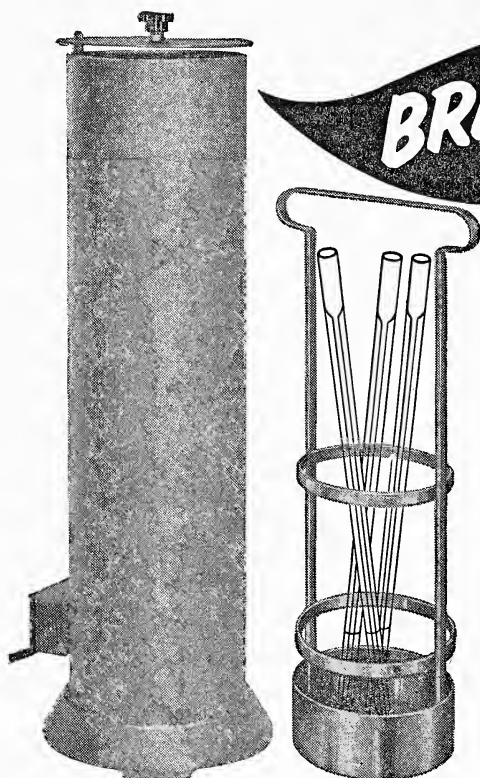
In June Professor Robert M. Hubbard of the Chemical Engineering Department of the University of Virginia attended a summer school for chemical engineering teachers on process dynamics held at Case Institute of Technology and sponsored by the National Science Foundation and the Foundation for Instrumentation Education and Research. Professor Hubbard has been elected Chairman of the Central Virginia Section of the American Institute of Chemical Engineers for the year 1960. Professor Otis L. Updike of the Chemical Engineering Department at the University was employed at the Oak Ridge National Laboratory during the summer. He is on leave of absence from the University during the academic year 1959-1960 and is working at the California Institute of Technology on a National Science Foundation Fellowship. In December he attended the annual meeting of the American Institute of Chemical Engineers in San Francisco.

Mr. Bernard Niemier is now Head of the Mechanical and Strain Measurements Group in the Metallurgical Research Laboratory of Reynolds Metal Company.

Robert M. Hubbard, *University of Virginia*

PSYCHOLOGY SECTION

Frank A. Geldard attended the organization meeting of the NATO Advisory Group on Defense Psychology, held at NATO Headquarters in Paris on November 2-3. Dr. Geldard is chairman of the Advisory Group which includes representatives from Italy, the Netherlands, France, the United Kingdom, and the United States. The chief business of the meeting was the laying of plans for an international symposium on defense psychology, to be held in Paris just prior to the 16th International Congress of Psychology at Bonn in July 1960. Areas to be encompassed by the symposium program are: Identification and assessment of human abilities,



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Frank W. Finger is president-elect of the Division of General Psychology of the American Psychological Association. At the 1959 meetings of the A.P.A. in Cincinnati, Richard H. Henneman read a paper (prepared jointly with Kenneth E. Lloyd) on "The Influence of Number of Different Stimulus Categories on Short-term Retention." William F. Battig chaired a session on Human Learning sponsored by the Division of Experimental Psychology.

At the Chicago meeting of the A.A.A.S. in December, the Vice-presidential address for Section I will be given by Frank A. Geldard from the University of Virginia. Dr. Geldard will speak on "Some Neglected Possibilities of Communication."

Four psychologists were approved for certification by the Virginia Examining Board for Certification of Clinical Psychologists after examination on November 4. They were George Killinger, Marion; Meredith Green, Winchester; Henry Adams, Richmond; and Luther Mays, Arlington. This brings to 63 the number of Certified Clinical Psychologists approved by the Virginia Examining Board.

At the fall meeting of the Virginia Psychological Association in Winchester, October 30, Capt. James F. Wade, Wright Air Force Base, presented a paper on weightlessness entitled "Human Factors in Stress and Space Flight." Joel Greenspoon, Director of the Clinical Psychology Training Program, Florida State University, gave the banquet address, "Clinical Aspects of Verbal Conditioning." The business meeting was delightfully informal; the treasurer had lost his report, but he assured the members that the funds were in a safe place. The president kept misplacing his brief case, and somehow the meeting found itself adjourned in the middle of a discussion. The Zeigarnik effect immediately clamped down on the group so that the discussion continued into the following social hour and occasional reverberations are still heard.

Henry Adams, McGuire VA Hospital, presented a paper at one of the meetings sponsored by Division 12, in Cincinnati, entitled "Preliminary Investigation of Behavioral Concomitants of Sensory Deprivation." This paper was also selected for inclusion on the program of the VA Symposium on Medical Research. Robert Gibby read the paper on this occasion, which was in Cleveland, Dec. 8-11.

John F. Hahn is the newly elected president of the University of Virginia chapter of the Society of the Sigma Xi; William F. Battig now serves as the chapter treasurer.

Charles C. Hodge, M.A., from the University of Mississippi has joined the William and Mary Psychology Department as Instructor for the year

1959-1960. Also, for the same year, David S. Camp, as Assistant Instructor.

George Gerken joined the Psychology Department at the University of Virginia in September. He comes from the University of Chicago where he carried on his doctoral research in auditory electrophysiology. Dr. Gerken also holds a degree in electrical engineering from Massachusetts Institute of Technology.

Kenneth E. Lloyd left the University of Virginia in August to join the Psychology Department at Washington State University, Pullman, Washington.

John McMillan, formerly of McGuire VA Hospital and more recently with Rohrer, Hibler, and Replogle, Atlanta, became Chief Psychologist, Department of Neurology and Psychiatry in the Medical College of Virginia, January 1, 1960.

Cyril R. Mill, *Department of Mental Hygiene and Hospitals*

STATISTICS SECTION

Dr. Boyd Harshbarger and Dr. H. A. David of the Department of Statistics of the Virginia Polytechnic Institute attended and presented papers at the Fifth Conference on the Design of Experiments sponsored by the Office of Ordnance Research, U.S. Army, held at Fort Detrick, Frederick, Maryland, November 4-6, 1959.

W. A. Glenn completed the requirements of a Ph.D. degree in Statistics and has accepted a position as Associate Professor in the Department of Statistics of the Virginia Polytechnic Institute.

Miss Carmen A. Perez and Mr. Giulio Damiani completed the requirements for their Masters degrees in Statistics at the Virginia Polytechnic Institute. Mr. Damiani is planning to return to his home in Italy.

The following members of the Department of Statistics of the Virginia Polytechnic Institute will attend and present papers at the joint Christmas meetings of the Institute of Mathematical Statistics, the American Statistical Association, and the Biometrics Society, ENAR, in Washington, D. C.: Drs. Boyd Harshbarger, W. A. Glenn, H. A. David, R. J. Freund, Rolf E. Bargmann, Clyde Y. Kramer; and Mr. David C. Hurst.

The Virginia Academy of Science Chapter of the American Statistical Association held a joint meeting with the Richmond Section of the American Society for Quality Control in October 24, 1959, at the Holiday Inn Restaurant, Lynchburg, Virginia. Four papers of an expository nature were presented. The meeting was attended by approximately twenty persons.

The following papers have been published by members of the Department of Statistics of the Virginia Polytechnic Institute:

"Analysis of Variance of a Randomized Block Design With Missing Observations," W. A. Glenn and C. Y. Kramer, *Applied Stat.* Nov. 1958.

"Errors Associated with Process Adjustments," J. Edward Jackson, Richard A. Freund, and William G. Howe, *Virginia Journal of Science*, 10 (1), 1959.

"Some Multivariate Statistical Techniques Used in Color Matching Data," J. Edward Jackson, *Journal of the Optical Society of America*, Vol. 49, No. 6, June, 1959.

"Tournaments and Paired Comparisons," H. A. David, *Biometrika*, Vol. 46 Parts 1 and 2, June, 1959.

"The Comparison of the Sensitivities of Similar Experiments: Model II of the Analysis of Variance," D. E. W. Schumann and Ralph A. Bradley, *Biometrics*, Vol. 15, No. 3, September, 1959.

Norbert L. Enrick was promoted to Associate Director of Research and Head of Operations Research Division, Institute of Textile Technology, in Charlottesville.

TIME STUDY MANUAL is the title of a book, written with particular reference to problems of continuous processing and complex machine-operator cycles, to be published in January 1960 by Interscience. It was prepared by twenty-seven contributors, mostly members of the Southern Textile Methods and Standards Association, and edited by N. L. Enrick.

Dr. Franklin E. Satterthwaite, professor at Merrimack College, head of the Statistical Engineering Institute, and consultant with Rath and Strong Inc., presented an all-day seminar on Statistical Methods in Poly-variable Experimentation for students and staff members at the Institute of Textile Technology. Special attention was given to Random Balance designs, of which Dr. Satterthwaite is the originator.

Clyde Y. Kramer, *Virginia Polytechnic Institute*

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NOTICE TO CONTRIBUTORS

Contributions to the Journal should be addressed to Robert T. Brumfield, Stevens Hall, Longwood College, Farmville, Virginia. If any preliminary notes have been published on the subject which is submitted to the editors, a statement to that effect must accompany the manuscript.

Manuscripts must be submitted in triplicate, typewritten in double spacing on standard 8½" x 11" paper, with at least a one inch margin on all sides. Manuscripts are limited to seven pages, with the proviso that if additional pages are desired, the author may obtain them at cost. The author may estimate the length of his paper by counting the total number of characters, including blank spaces, and dividing this by 3300. The result is the approximate number of printed pages in the Journal.

Division of the manuscripts into subheadings must follow a consistent plan, and be held to a minimum. It is desirable that a brief summary be included in all manuscripts.

Footnotes should be included in the body of the manuscript immediately following the reference, and set off by a dashed-line above and below the footnote content. Footnotes should be numbered consecutively from the beginning to the end of the manuscript.

Bibliographies (Literature Cited, References, etc.) should be arranged alphabetically according to author. Each reference should include the date, full title of the article, the name of the Journal, the volume, number (optional), pages, tables and figures (if any). For example: "Sniffen, Ernest W. 1940. Cobbles from the Pleistocene Terraces of the Lower York-James Peninsula Va. *Journ. Sci.*, 1 (8): 235-288 1 fig., 1 tab. Reference to the bibliographic citations should not be made by numbers. Instead, using the above citations, where a reference is desired: either "Sniffen (1940)", (Sniffen, 1940: 186)", or "Sniffen (1940) states that . . ."

Explanation of figures, graphs, etc., should be typed on separate pages. All figures should be numbered consecutively beginning with the first text figure and continuing through the plates. If figures are to be inserted in the text this should be clearly indicated by writing "Figure —" at the appropriate place in the margin.

Illustrations including lettering, should be arranged so that on reduction they will not exceed the dimensions of the maximum size of a printed page. 4-1/2" x 6-1/2", and so that they are well balanced on the page. Large plates must be accompanied by 8-1/2" x 11" photographic copies which can be sent to the reviewers. The Journal will furnish the author with one plate (halftone or line reproduction) or its equivalent; additional figures, colored illustrations or lithographs may be used only if the author makes a grant covering the cost of production. Original drawings (which must be done in black drawing ink) not photographs of drawings, should accompany the manuscript. Photographs should not be used if a line and dot (stippled) drawing will suffice. If photographic prints are to be used they should be glossy, sharp and show good contrast. Drawings not neatly executed and labeled (do not use a typewriter), or which are submitted on yellow or yellowish-white paper will not be accepted.

Galley Proofs and engraver's proofs of figures are sent to the author for correction. Costs of excessive changes from the original manuscript must be defrayed by the author.

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C O N T E N T S

Pages

The Genus <i>Ceratodrilus</i> Hall, (Branchiobdellidae, Oligochaeta) with the Description of a New Species	53
Program of the 38th Annual Meeting, Virginia Academy of Science	81

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The Genus *Ceratodrilus* Hall, (Branchiobdellidae, Obligochaeta) With The Description of A New Species

Perry C. Holt

Department of Biology, Virginia Polytechnic Institute
Blacksburg, Virginia

The majority of the species of the family Branchiobdellidae are monotonously similar in superficial appearance, but this general uniformity of external structure is occasionally departed from by some species in a most dramatic fashion. Notable in this respect among the North American branchiobdellids are such forms as *Pterodrilus alcicornus* Moore and the curiously ornamented species of *Ceratodrilus* which are the subjects of the present investigation.

These aptly named "horned worms," however, compel our attention and interest for several reasons other than their appearance. *Ceratodrilus* is endemic to a geologically interesting area and, moreover, the type species, *C. thysanosomus* from Utah, has been referred to *Cirrodrilus* Pierantoni, a genus of Japanese worms. Such a relationship, if real, would be a matter of considerable zoogeographical importance. Furthermore, the material at hand reveals the presence in the Snake River basin of a second, undescribed, species of the genus and, finally, the acquisition of a large number of specimens of both these species as the result of a collecting trip made in the summer of 1958 presents an opportunity to study the internal anatomy of these species. A phylogenetic synthesis of the family Branchiobdellidae waits in part on the completion of such anatomical studies.

Although the genus *Ceratodrilus* has been briefly and almost cursorily treated by only three authors, the history of these treatments has its points of interest. The story begins in 1905 when Pierantoni erected the genus *Cirrodrilus*, with *C. cirratus* as the only species, on the basis of several ill-preserved individuals which were obtained from specimens of

the Japanese crayfish *Cambaroides japonicus* possessed by the Museum de Histoire Naturelle de Paris. Pierantoni's diagnosis (according to Yamaguchi, 1932a: 364) appears to have been based primarily upon what he believed to be ventrally placed transverse ridges bearing finger-like projections. In 1914, Hall diagnosed the genus *Ceratodrilus*, designating *C. thysanosomus* as the type species, on the basis of material from the Great Salt Lake basin in Utah which was likewise admitted to be in a state of poor preservation. Yamaguchi (1932a) studied some Japanese branchiobdellids and referred worms which he considered to be conspecific with Pierantoni's animals to Hall's genus *Ceratodrilus*, ignoring the priority of *Cirrodrilus* as a generic name. This assignment was based on Yamaguchi's undoubtedly correct view that Pierantoni confused the dorsal with the ventral surface of his worms and upon Hall's description of the dorsal projections of *Ceratodrilus*. Goodnight (1940: 63-64) reviewed the work of Hall and Yamaguchi, concurred with Yamaguchi's view that the American and Japanese species are congeneric and corrected Yamaguchi's violation of the law of priority, thereby reducing Hall's genus *Ceratodrilus* to synonymy.

It is immediately obvious that both Pierantoni and Hall based the diagnosis of their genera upon the external appearance of poorly preserved material; that Yamaguchi had no opportunity to study American material and made his decision to synonymize the Japanese and American genera on the basis of external form; that Goodnight simply accepted Yamaguchi's conclusions and assigned his material from the Snake River basin in Idaho and Oregon to Hall's species without considering whether these Snake River animals might represent a species other than Hall's Utah one. Goodnight did not study the internal anatomy of his animals and, hence, made no attempt to determine whether they, or Hall's, correspond to Yamaguchi's in this respect. They do not, as this investigation shows.

One objective of this paper is to establish the generic distinctiveness of the American worms and, hence, to revive Hall's genus *Ceratodrilus*. Since Japanese material is not available in America, the validity of this effort depends upon a careful interpretation of Yamaguchi's descriptions and figures. Without attempting to follow the changes in Yamaguchi's papers (1932a, 1932b, 1933, 1934), attention is directed to what appear to be his final conclusions as found in his monograph of the Japanese branchiobdellids (1934). Here he again ignored priority and placed the Japanese species *Cirrodrilus cirratus* in Pierantoni's genus *Stephanodrilus*. If Yamaguchi was correct in believing that Pierantoni's *Cirrodrilus cirratus* (1905) and *Stephanodrilus sapporensis* (1906) are congeneric, then *Stephanodrilus*, not *Cirrodrilus*, becomes a junior synonym. But this is not important to the present argument. What is important is that Yamaguchi considered the species of *Cirrodrilus* and *Stephanodrilus* to be congeneric

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and his concept of the genus, which, if he and Goodnight were correct, would embrace the American species upon which Hall erected his genus *Ceratodrilus*.

Consequently, Yamaguchi's concept of the genus *Stephanodrilus* must be considered. The pertinent point is that Yamaguchi understood the structure of the male reproductive system of the branchiobdellids, including the American genus *Cambarincola* which has an introduced representative in Japan (1934: 191). He wrote (1934: 190-191) that the latter has an accessory sperm tube (=prostate, see below). In his paper on what he then called *Cambarincola homodonta* (1932c: fig 2) a species he later placed in *Stephanodrilus* (1934: 200-201), he presented drawings of the spermatic vesicles (=spermiducal glands, see below) and atria (=bursae and penial sheaths, see below) of several species of branchiobdellids. These drawings clearly show that there is no prostate in *Stephanodrilus sapporensis* and in *S. homodonta*, while his drawing of *Cambarincola* sp. shows the typical structure of the male reproductive system of this genus. The species originally called *Carcinodrilus nipponicus* was at first considered generically distinct from those assigned to *Ceratodrilus* [= *Cirrodrilus*] and *Stephanodrilus* on the basis of differences in the external form, but the statement is made (1932b: 63) that these genera are "generally similar" in internal structure. It is implicit in Yamaguchi's 1934 paper and previous work that he made his decision to assign the fairly numerous species of Japanese worms to the three genera *Branchiobdella*, *Cambarincola* and *Stephanodrilus* on the basis of differences in the structure of the male reproductive system. Be this as it may however, Yamaguchi gave clear enough description of the male reproductive system of the Japanese worms to establish the generic distinctiveness of the American ones.

As further evidence bearing on this point, he figured the "atrium" (=bursa, penial sheath and spermiducal gland) of *Stephanodrilus inukaii*. This drawing, reproduced here (fig. 1), is entirely consistent with his earlier ones mentioned above. The essential points to note are the absence of the prostate and the point of entry of the vasa deferentia into the spermiducal gland. He then remarked for all of the fifteen species (with the exception of Pierantoni's *Stephanodrilus japonicus* which he did not see) that the male reproductive system is generally similar and made it clear that it corresponds in all these species to the drawings he presented of *S. inukaii*, *S. sapporensis* and *S. homodonta*. The Japanese worms which Yamaguchi assigned to *Stephanodrilus* constitute a coherent group and are congeneric according to the generic concept adhered to in this paper.

Yamaguchi's (1934: 191-192) diagnosis of *Stephanodrilus* was somewhat long and emphasized the external features perhaps unduly. A condensed version, however, would read: peristomium always 8-lobed dor-

sally, the lobes often prolonged into tentacles, frequently with a membranous funnel-like extension of the peristomium between the lobes; with or without dorsal transverse bands and projections; anterior nephridiopores usually paired, unpaired in *S. koreanus* [?]; both dorsal and ventral jaws with 7 or more teeth, including always a large median one; "testes and male funnels in trunk somites V and VI; atrium of [a] glandular part, muscular portion and bursa, no distinct penis sheath; glandular atrium not bifid, [but] tubular or bulged [in] form; no paired bursal glands; penis sub-conical in form, having a narrow eversible efferent duct folded several times at the basal portion; spermatheca not bifid and composed of two enlarged portions, one in the distal [read "ental" (?)] end, the other in about the middle portion, lumen [sic] of the two portions connected by a very narrow canal."

This constitutes a coherent generic diagnosis and one would question only the unpaired nephridiopore of *S. koreanus* and the absence of a statement concerning the point of entry into the spermiducal gland (glandular atrium) of the deferent ducts. The first may simply be an error; if not, the Korean species probably represents a different genus. The latter point is important and it is clear from Yamaguchi's drawings and descriptions that the Japanese genus, properly known as *Cirrodrilus*, is characterized in part by the fact that the deferent ducts enter the spermiducal gland at a point about one-fourth the length of the gland entad from the junction of it and the ejaculatory duct (fig. 1), as in the American genus *Xironogiton* (Holt, 1949: 541) which otherwise appears to be quite distinct from the Japanese genus.

There is no reason to doubt the accuracy of Yamaguchi's observations with the exceptions noted. There are, then, two known indigenous genera of branchiobdellids, *Branchiobdella* Odier, 1823, and *Cirrodrilus* (including *Stephanodrilus*) Pierantoni, 1905, and the introduced American species of *Cambarincola* in Japan and Korea.

Goodnight (1940: 63) concurred with Yamaguchi's error in reducing the American genus *Ceratodrilus* to synonymy with the Japanese genus *Cirrodrilus*. A brief consideration of Goodnight's treatment, therefore, becomes pertinent.

Goodnight (1940: 63) defined *Cirrodrilus*, including *Ceratodrilus*, as follows: "With the characteristics of the subfamily [two pairs of testes]; spermatheca simple, not bifid; no accessory sperm tube; anterior nephridia opening to the outside through separate pores in the dorsal half of segment III; penis eversible; body cylindrical, not depressed; with body appendages in the form of pointed bands extending transversely across the dorsal surface." His discussion of the genus was short and consisted of a quotation from Yamaguchi justifying the combining of the genera on

the basis of Pierantoni's error. Goodnight, then, left the matter precisely at the point reached by Yamaguchi, except for his correction of Yamaguchi's error in regard to priority.

MATERIALS AND METHODS

Materials collected and preserved in alcohol-formalin (70% alcohol, 96 parts; 40% formalin, 4 parts) were studied by means of whole mounts and serial sections. Animals mounted entire were dehydrated with alcohol, cleared in clove oil and mounted unstained in balsam. Sections, cut at 10 microns, were stained with Delafield's hematoxylin and eosin according to the usual procedures. Entire animals were studied with a fluorite oil immersion objective, 40X, N.A. 100, corrected to a working distance of 1.5 mm., and sections with an apochromatic, 47.5X, N.A. 0.95 objective and an apochromatic, 90X, N.A. 1.30 oil immersion objective. All drawings were made with the aid of a camera lucida. Specimens cited which are in the collections of the author are identified by the initials PCH.

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Ceratodrilus Hall, 1914

Ceratodrilus, Hall, 1914: 190-191; *Ceratodrilus*, Stephenson, 1930: 901; *Cirrodriulus*, Goodnight, 1940: 63-64.

DIAGNOSIS. — Medium sized worms, 3.0 to 3.3 mm. in average length for the known species; finger-like projections borne on the dorsal surface of segments ii-vii; peristomium with four tentacles; a single anterior nephridiopore, opening mid-dorsally on the transverse ridge of segment iii; jaws relatively heavy, brown, teeth subequal in length, dental formula 7/6; prostate reduced to a lateral prostatic bulb near the ental end of the spermiducal gland; spermiducal gland prominent, deferent ducts

enter its ental end; ejaculatory duct present, short and thick; penial sheath relatively short and thick, enclosing an eversible penis, externally only slightly delimited from the atrial portion of the bursa; spermatheca with a wide and prominent ectal stalk and an ental process.

TYPE SPECIES. — *Ceratodrilus thysanosomus* Hall, 1914, by original designation.

DISTRIBUTION. — The species of *Ceratodrilus* seem to be confined to the Snake River drainage and its Pleistocene extension into Lake Bonneville (fig 2). Hall's original material came from "streams of Great Basin, Salt Lake City, Utah," and Goodnight's subsequent records should, with the exception of the animals from Evanston (Bear River), Wyoming, be assigned to the new species described below. That the animals from the Snake River and its tributaries are specifically distinct from those of the Great Salt Lake drainage and that the genus is known only from these two formerly connected drainage systems may imply the post-Pleistocene differentiation of these species.

AFFINITIES OF THE GENUS CERATODRILUS. — The Phylogenetic relationships of the branchiobdellid genera are not known and a discussion of the affinities of *Ceratodrilus* is further complicated by the fact that several unnamed genera are known. The preponderance of morphological evidence indicates that *Ceratodrilus* is more closely related to such American genera as *Cambarincola* and *Pterodrilus* and perhaps most closely of all to one of the undescribed genera in the author's collections. No genus of branchiobdellids is known with certainty to range over more than one continent — Pierantoni's (1912: 14, 16) report of the presence of *Branchiobdella* in America remains unconfirmed and the Japanese species assigned to the genus may well represent a new genus of the subfamily Branchiobdellinae. It begins to appear, therefore, that there are two, and perhaps three distinct faunal assemblages of these worms.

A further comparison of *Ceratodrilus* with the known genera of branchiobdellids is given below in conjunction with a discussion of the anatomy of the genus.

Ceratodrilus thysanosomus Hall, 1914

(Plate III, figs. 11 and 12)

Ceratodrilus thysanosomus, Hall, 1914: 191; *Ceratodrilus thysanosomus* Stephenson, 1930:801; *Ceratodrilus thysanosomus*, Yamaguchi, 1932a: 367; *Cirrodrilus thysanosomus*, Goodnight, 1940: 64-65 (in part).

DIAGNOSIS. — About 3.2 mm. in length (preserved material); head with 4 tentacles which average approximately 90 microns in length; transverse dorsal ridges bearing 4-6 finger-like projections on segments ii-vii, about 50 microns in length; segment viii with 7-8 such projections which are somewhat shorter; dorsal projections approximately 1/10 body diameter in length; spermiducal gland large, reaching almost to dorsal border of segment vi; prostate reduced to prostatic bulb which opens directly into the lumen of the spermiducal gland near the ental end.

DISCUSSION. — Hall (1914: 191) described his animals upon which the original species diagnosis was based as 2 to 2.8 mm. in length with a maximum head diameter of 400 microns, a maximum body diameter of 660 microns, a maximum sucker diameter of 360 microns and a maximum length of the tentacles of the head of about 180 microns. In his generic diagnosis based on this species, he said that the lobes of the peristomium are provided with 4 or 5 papillae each; "the first seven trunk segments are furnished with dorsal appendages extending from the lateral border in a pointed band, the number of points usually 6, but on some segments 7 or 8 . . . penis eversible."

The specimens upon which this study is based are apparently larger than Hall's (table 1). All the measurements which follow are of ten mature specimens selected for mounting and hence larger than the average for the entire series. The average is given first, followed by the range in parentheses for these ten specimens. The body length is 3.2 mm. (3.0-3.6 mm.). This difference between these animals and Hall's is almost surely of no importance. The head diameter of the animals studied is .32 mm. (.31-.40 mm.); the diameter of segment vi is .49 mm. (.39-.55 mm.); sucker diameter is .31 mm. (.29-.35 mm.); the tentacles are .09 mm. (.06-.11 mm.). No conclusions can be drawn by the comparison of these measurements with those made by Hall except that within somewhat wide limits they are similar and there is almost surely a degree of overlapping in all of them.

The oral papillae of specimens studied (fig. 4) number 14-16. It is difficult to count them, and one cannot be sure of the exact number in any case. The difference between Hall's and the author's counts are almost certainly due to this difficulty.

Hall's statement that the dorsal projections are on segments i to vii ("the first seven trunk segments") is erroneous; his illustration shows clearly the first row of projections on segment ii. More importance should be attached to the statement that there are "usually 6" dorsal projections in each row. There are 8 projections on segment viii of the material studied as is apparently the case for Hall's, and the other projection bear-

ing segments have four, sometimes five. There is some variability in this character and only more collecting can determine whether these differences constitute a specific or subspecific difference or whether they are simply an expression of intra-specific variability. Since the author's collection was taken from a region within the type locality of Hall's species and there is doubt about all detectable differences, these specimens are assigned to *C. thysanosomus*.

The penis of these animals is eversible as Hall states is true of his. A fuller description of the reproductive systems and other points not mentioned by Hall is presented below.

TYPE LOCALITY.—Streams of Great Basin, Salt Lake City, Utah (Hall, 1914: 191).

ADDITIONAL LOCALITY RECORDS. — Evanston, Bear River, Wyoming, (Goodnight, 1940:65), on *Pacifastacus gambelii* (Girard). This is in the Great Salt Lake drainage and the record is probably valid.

Paris, Idaho. Host: *P. g. gambelii*. Oct. 28, 1950. Collector: D. Eldon Beck (PCH 424, U.S. Nat. Mus. No. 29916).

Brigham City, Box Elder County, Utah, two miles east of Brigham City on U.S. Highways 89 and 91. On *P. g. gambelii* taken from a cold, rocky, medium sized stream of the Wasatch Mountains, July 13, 1958. Collectors: P. C. and V. F. Holt (PCH 781, U. S. Nat. Mus. No. 29915).

DISPOSITION OF MATERIALS.—Type specimens: Cat. No. 17708, U. S. Nat. Mus. (Bureau of Animal Industry Helminthological Collection) (Hall, 1914: 191).

Material upon which this study is based consists of several specimens mounted entire, U.S. Nat. Mus. Nos. 29915 and 29916, and numerous specimens, including serially sectioned ones, in the author's collection (PCH 424 and 781).

Ceratodrilus orphiorhysis, n. sp.

(Plate IV, figs. 13-16)

DIAGNOSIS.—About 3.0 mm. in length (preserved material); head with 4 tentacles which average 200 microns in length; with 6 dorsal projections averaging 146 microns in length on segments ii to vii; segment viii with 8 projections which average 94 microns in length; dorsal projections approximately 1/4 body diameter in length; spermiducal gland extending dorsad about 2/3 the diameter of the segment; prostate con-

sisting of a larger and more obvious prostatic bulb than that of *C. thysanosomus*, emptying into the lumen of the spermiducal gland near the ental end.

DISCUSSION.—*C. ophiorhysis* is closely related to *C. thysanosomus*. Externally, these species differ strikingly in appearance; a difference almost, if not entirely, due to differences in proportion. The general similarity of internal structures revealed by a study of prepared material is somewhat surprising. A more detailed account of the anatomy of both species is given here in the following section.

C. ophiorhysis has been taken at several localities in the Snake River. Goodnight's (1940:65) records of *C. thysanosomus* from Idaho and Oregon are here assigned to *C. ophiorhysis* on the basis of this distribution.

TYPE LOCALITY—Snake River, between Buhl and Wendel, Gooding County, Idaho. Host: *Pacifastacus gambelii connectans* (Faxon). July 14, 1958. Collectors: P. C. and V. F. Holt and Judson Ford (PCH 786).

ADDITIONAL LOCALITY RECORDS.—Burley, Cassia Co., Idaho, (Goodnight, 1940: 65) on *P. gambelii*.

"Bvous" [=Burns], Harney County, Silver River, Oregon (Goodnight, 1940: 65), on *P. gambelii*.

Crow Creek, South River, Lincoln County, Wyoming. Host *P. g. gambelii*. Sept. 14, 1946. Collector: Tracey, (PCH 420).

Shoshone Falls, Jerome County, Idaho. Host: *P. g. connectans*. June 15, 1928. Collector: D. Eldon Beck (PCH 423).

Bridge, Cassia County, Idaho. From Raft River on county road between Bridge and Almo. Host: *P. g. gambelii*. July 13, 1958. Collectors: P. C. and V. F. Holt and Ray Bronson (PCH 782; U.S. Nat. Mus. No. 29913).

Hagerman, Gooding County, Idaho. Cold spring in Snake River Canyon. Host: *P. g. gambelii x g. connectans*. Collectors: P. C. and V. F. Holt and Judson Ford (PCH 784; U.S. Nat. Mus. No. 29912).

Idaho Fish Hatchery, Riley Creek, Gooding County, Idaho. From head race of fish hatchery. Host: *P. g. connectans*. July 14, 1958. Collectors: P. C. and V. F. Holt and Judson Ford (PCH 785; U.S. Nat. Mus. No. 29914).

DISPOSITION OF MATERIAL.—The holotype, U. S. Nat. Mus. No. 29910, and four paratypes, U.S. Nat. Mus. No. 29911 and those noted above, are

deposited in the United States National Museum. Three paratypes and the numerous remaining specimens are retained in the author's collection.

REMARKS ON THE ANATOMY OF *Ceratodrilus*

A genus based on two closely related species, one newly described, should be subjected to a careful anatomical study. The proper placing of any subsequently discovered allied species and an understanding of the evolution of the family depend on such studies.

A minor task, however, takes precedence. The nomenclature applied to the various parts of the reproductive systems of the branchiobdellids is in a state of confusion and this opportunity is taken to define terms that will be used in the future for these structures. No implications of homology should be understood, though an effort has been made to use terms that apply to structures which, if not homologous throughout the Oligochaeta, are at least analogous and generally similar in structure. References are made to Stephenson (1930) where applicable; new usages are italicized.

TERMS APPLIED TO THE MALE REPRODUCTIVE SYSTEM.—1. Testis. The testes of the branchiobdellids are paired proliferations of the posterior faces of septa 4/5 and 5/6, or 4/5 only, and are not patent in the adults of any described species known to the author.

2. Morula. A morula is a group of spermatogonia or spermatocytes. The testis at maturity breaks up, releasing the morulae which with the resulting spermatozoa fill the coeloms of segments v and vi, or v in the case of *Branchiobdella* which has only one pair of testes (Stephenson, 1930:443).

3. Blastophore. A blastophore consists of the residual cytoplasm of a morula (Stephenson, 1930:446).

4. Male funnels. Openings of efferent ducts into the coeloms of the testicular segments through which spermatozoa enter the male efferent system, common to all oligochaetes, are generally called the male funnels. A pair of funnels are located in the posterior ventral portion of each testicular coelom.

5. Efferent ducts (*vasa efferentia*). The male funnels open into the efferent ducts which in turn unite ventrally to form a deferent duct for each testicular segment.

6. Deferent ducts (*vasa deferentia*). The deferent ducts course in the ventral body wall and then freely in the coelom of segment vi where they

unite to form the spermiducal gland.

7. Spermiducal gland. In the usage of Beddard (Stephenson, 1930: 357), spermiducal glands are any glands associated with the male system. Here the term is restricted to a glandular organ formed by the union of the deferent ducts—the glandular “spermatic vesicle” of Moore (1895: 520) and the “glandular atrium” of various authors.

8. Prostate. A term used for various types of glands associated, usually directly, with the male reproductive system of the oligochaetes; it is here applied to the structure called the “accessory sperm tube” by Ellis (1912: 483). The prostate opens into the spermiducal gland, or the two unite at the point where the spermiducal gland becomes muscular to form the ejaculatory duct, and ends blindly entally. Histologically, the prostate may be similar to or different from the spermiducal gland.

9. *Prostatic bulb*. The prostatic bulb is a bulb-like structure composing the ental closed end of the prostate. It is formed of flattened, non-glandular cells and is not present in all species.

10. Ejaculatory duct (Holt, 1949:542). The ejaculatory duct is a muscular portion of the male reproductive system between the spermiducal gland and the penis formed by its ectal end. It was called the muscular sperm sac by Moore (1895: 521).

11. Bursa. The ectal muscular portion of the male reproductive system is usually called the bursa. The following portions of this organ are here recognized: a. penial sheath (Moore, 1895: 521). The penial sheath is a muscular investment of the protrusible or eversible portion of the ejaculatory duct which forms the penis and is similar to the “atrial sac” described by Benham and called the penial sac by Stephenson (1930: 348). b. penis. The protrusible or eversible, possibly intromittent, ectal portion of the ejaculatory duct is known as the penis. c. atrium. The atrium is a sac-like invagination of the body wall forming a cavity into which the penis opens when withdrawn. The muscular wall of the atrium is continuous with the penial sheath and is eversible in most, not all, genera of the branchiobdellids.

12. Male pore. The outlet pore of the bursa through which the penis everts or is protruded is generally referred to as the male pore.

TERMS APPLIED TO THE FEMALE REPRODUCTIVE SYSTEM.—The ovaries and ovipores constitute the primary female organs of the branchiobdellids. They are located in segment vii. The unpaired spermatheca of segment v varies enough in structure to justify the introduction of a few descriptive terms.

1. *Spermathecal bursa*. An invagination of the body wall surrounding the outlet pore of the spermatheca is here recognized and named the spermathecal bursa. In some species it may be eversible.
2. *Spermathecal duct*. The spermathecal duct is a glandulo-muscular part of the spermatheca which does not normally store spermatozoa (Holt, 1955: 29).
3. *Median duct*. Usually absent, the median duct is a narrowed region which connects the enlarged spermathecal duct of some species and the spermathecal bulb.
4. *Spermathecal bulb*. The spermathecal bulb is a thin walled portion of the spermatheca, usually expanded, serving for the storage of spermatozoa and sometimes glandular in structure (Holt, 1955: 29).
5. *Ental process*. The ental process is a narrowed, glandular, ental projection of the spermathecal bulb.

BODY SHAPE AND SIZE.—The general appearance of the worms treated in this paper is best presented visually (figs. 4, 11 and 13). The mea-

Table 1. A comparison of *Ceratodrilus thysanosomus* and of *C. ophiorhysis* with respect to six characters. (all measurements are in millimeters and are based on ten animals.)

	<i>C. thysanosomus</i>		<i>C. ophiorhysis</i>	
	Average	Range	Average	Range
Head				
length	.47	.45-.51	.47	.40-.51
diameter	.32	.31-.34	.33	.28-.37
Body				
length ¹	2.76	2.57-3.08	2.52	2.01-2.80
Diameter				
Segment i	.30	.28-.34	.39	.24-.34
Segment vi	.49	.40-.55	.53	.40-.81
Sucker	.31	.29-.35	.36	.28-.40

¹exclusive of head.

surements given in table 1 are comparable¹ and show that *C. ophiorhysis* apparently tends to be a slightly shorter and thicker worm. *C. thysanosomus* has proportionally much shorter dorsal projections and cephalic tentacles and the body is usually flexed to a greater extent. The result is that the subjective impression is the reverse of what the measurements show.

The most obvious differences between the two species of *Ceratodrilus* are the lengths of the cephalic tentacles and dorsal projections. The measurements presented in table 2, and a comparison of the illustrations (figs. 11 and 13), show that there is no overlap in the lengths of characters; that the tentacles and projections of *C. ophiorhysis* are consistently twice, or more, the length of those of *C. thysanosomus*.

The digestive, circulatory and nervous systems of the branchiobdellids furnish little in the way of variety of use in systematics. No attempt was made to study these systems in *Ceratodrilus*. The gut is straight and sacculated in each segment in contrast to the loops in the segment vii of

Table 2. A comparison of lengths of the dorsal projections of segments ii, iv, vi, viii and of the cephalic tentacles of *Ceratodrilus thysanosomus* and *C. ophiorhysis*. (the figures are given in microns and are based on ten animals of each species selected at random and mounted entire in balsam.)

<i>C. thysanosomus</i>			<i>C. ophiorhysis</i>	
	Average	Range	Average	Range
Dorsal Projections of Segments				
ii	53	24-95	176	119-254
iv	52	32-80	146	119-198
vi	44	24-64	115	87-151
viii	44	32-56	94	71-111
Cephalic Tentacles				
	88	56-111	201	135-278

¹ The animals were collected on successive days. Ten, randomly selected for mounting entire, were measured.

Xironogiton, and empties dorsally through the anus on segment ix.

Oral papillae have been mentioned by a few authors other than Hall. Yamaguchi (1934:195) remarked that there are sixteen for one of his species. No one seems to have determined whether or not the numbers of these structures vary among the branchiobdellids. There appear to be (fig. 4) sixteen in *Ceratodrilus ophiorhysis*.

JAWS. — The jaws of the branchiobdellids are cuticular thickenings of the posterior pharyngeal region located presumably in the posterior part of the first cephalic segment (the segmentation of the "head" of the branchiobdellids is not entirely clear). The size, shape and general appearance of these structures seem to be similar for groups of species, hence of some importance as generic characters. Those of the species of *Ceratodrilus* are relatively heavy, dark in color, crescentic in dorsal or ventral views (figs. 15 and 16), triangular in lateral view and essentially rectangular in frontal view. The dorsal jaw bears seven teeth; the ventral, six. Hall's (1914: 191) illustrations show the frontal aspect of the jaws of *Ceratodrilus thysanosomus* quite well. The jaws of the species of *Cirrodrilus* are markedly triangular in frontal aspect and those of *Ceratodrilus* are not closely similar to those of any branchiobdellids known to the author.

NEPHRIDIOPORE. Hall (1914: 191) was unable to determine whether the anterior nephridia of *C. thysanosomus* have a common opening or separate ones. Yamaguchi in his diagnosis of *Stephanodrilus* [= *Cirrodrilus*] said that there are paired ones in this genus. Goodnight (1940:63) apparently accepted this condition as true of *Ceratodrilus* when he concurred with Yamaguchi's opinion that these genera should be united. As remarked above, the nephridia of *Ceratodrilus* open to the outside through a common pore located mid-dorsally on the transverse ridge of segment iii (fig. 9). The outlet ducts of the nephridia enter the body wall laterally and course dorsad between the longitudinal and circular muscles. At the point of junction of these two ducts there is a slight dilation. Associated with this junction are a few cells which take a deeper basic stain than do those of the nephridial ducts and are apparently glandular in nature. The common outlet duct is quite short, the lumen is essentially collapsed and the nephridiopore itself is not raised above the surrounding part of the dorsal ridge. A common nephridiopore is characteristic of the genera *Cambarincola* Ellis, *Bdellodrilus* Moore and *Pterodrilus* Moore.

THE MALE REPRODUCTIVE SYSTEM. The anatomical studies reported here concern structures which vary from one group of branchiobdellids to another and are, therefore, of importance in systematic studies. The various parts of the male reproductive system differ somewhat in size

Table 3. A comparison of selected dimensions of the reproductive organs of *Ceratodrilus thysanosomus* and *C. ophiorhysis*. (the figures are given in Microns and are based on ten animals of each species, selected at random and mounted entire in balsam.)

<i>C. thysanosomus</i>			<i>C. ophiorhysis</i>	
	Average	Range	Average	Range
Length of Bursa	286	244-339	300	260-331
Diameter of Bursa	154	118-173	157	118-181
Length of Spermiducal Gland	318	276-434	283	237-355
Diameter of Spermiducal Gland	111	94-118	89	79-94
Diameter of Spermathecal Duct	120	111-142	102	79-118
Diameter of Spermathecal Bulb	112	79-142	110	94-126

in the two species and a series of measurements of these are reported here (table 3). It is felt that ultimately such measurements, when treated statistically, may be of value in defining closely related species. *C. thysanosomus* and *C. ophiorhysis* are distinct in other respects and no attempt was made to determine the level of significance of the differences of means in the measurements reported.

The measurement of these structures is difficult, since they often lie obliquely to the horizontal plane. Those for the diameter of a cylindrical organ are felt to be somewhat more reliable than the others. The bursae of the two species appear to be of the same size. The spermiducal gland of *C. thysanosomus* is larger than that of *C. ophiorhysis*; a noticeable difference which accounts for the more crowded appearance of segment vi of the former species. The spermatheca of *C. thysanosomus* may

also be somewhat larger than that of *C. ophiorhysis*.

Other than that both segments v and vi are testicular segments, the testes of *Ceratodrilus* are not apparent at maturity and nothing further can be said about them. The coeloms of the mature testicular segments are filled with spermatozoa. The male funnels of the branchiobdellids do differ from species to species in shape and size; those of *Ceratodrilus* flare widely and are somewhat shorter in total length than the diameter of the flared ental end. *C. ophiorhysis* may possess funnels with a somewhat wider ental end, but this subjective opinion is unconfirmed by measurements. Some variability in the location of the funnels seems to occur: in *C. thysanosomus* both funnels of a segment have been found on the same side of the segment quite close together, an arrangement of the funnels not known for any other branchiobdellid. Nothing of importance was noticed concerning the efferent and deferent ducts.

Spermiducal gland: The spermiducal gland of *Ceratodrilus* is histologically similar to that of other species of branchiobdellids (Moore, 1895: 521; Holt, 1949: 542, 552). Since the organ is composed of a glandular lining epithelium covered with a thin muscular coat and a thinner peritoneal layer, the gland cells are very tall columnar cells with basal nuclei. They contain droplets of secretory material towards their outer ends (fig. 10). Occasionally, there are cilia present projecting into the lumen of the gland (one specimen of *C. ophiorhysis*), but apparently this is not characteristic. Always there is a meshwork of secreted material in the lumen of the gland.

The deferent ducts enter the gland at its ental end and in *C. thysanosomus* the gland is indented, not as much as in some species of *Cambarincola*, between the places of entry of the ducts, but more, as far as could be determined, than in *C. ophiorhysis* (figs. 12 and 14). The difference in size of the spermiducal glands of the two species of *Ceratodrilus* has been commented upon above. *Cambarincola* and *Pterodrilus* have spermiducal glands most nearly like that of *Ceratodrilus* among the genera of branchiobdellids which are well known.

Prostate: The prostate of both species of *Ceratodrilus* is reduced to nothing other than the prostatic bulb. That of *C. ophiorhysis*, however, is more apparent in whole mounts (fig. 14); while that of *C. thysanosomus* frequently cannot be seen at all in such preparations (fig. 12). The prostatic bulb consists of flattened epithelial cells that, from their appearance in hematoxylin-eosin stained sections, may well be muscular (fig. 10). The cavity of the bulb communicates directly by a very narrow, hardly perceptible, lumen which is filled with a secretion, with the lumen of the spermiducal gland. A prostate in developed form is found

in the genera *Cambarincola* and *Pterodrilus*. The prostatic bulb is found in some species of *Cambarincola*. In both these genera the prostate, lying closely applied to the spermiducal gland and enclosed with it by the peritoneal covering, opens into the lumen of the spermiducal gland at the point where it becomes muscular to form the ejaculatory duct.

Ejaculatory duct: Histologically, the ejaculatory duct resembles that of other branchiobdellids in which it occurs (Holt, 1949:542, 553). It is, however, relatively prominent in *Ceratodrilus* (figs. 12 and 14) and the lumen is distinct. This structure is called the muscular sperm sac by Moore (1895:521) and is apparently not distinguished from the penial sheath by many authors who call all parts of the male reproductive system ectad to the deferent ducts the atrium. It is known to be absent in *Xirondrilus* and in some species of *Branchiobdella*.

Bursa: The atrial part of the bursa is fairly large in *Ceratodrilus* (table 3) and as always consists of an invagination of the body wall. It is subspherical in shape (figs. 12 and 14) and is eversible (fig. 7). The inner edge of the inwardly projecting layer of epitheliomuscular lining epidermis of the withdrawn atrium (fig. 3) becomes the outer rim of the cup-like, everted atrium (fig. 7). The muscles of the atrium proper are primarily circular with reference to the organ itself, although the organ is so heavily muscular and the muscle fibers are so hard to trace, that the presence of radial muscles, at least, is not ruled out. The penis projects into the ental portion of the cavity of the atrium. In short, the atrium of *Ceratodrilus* is much like that of other branchiobdellids.

The penial sheath is limited entally by the narrowing of the ejaculatory duct and the beginning of a covering of longitudinal (in reference to the organ itself) muscle fibers. Ectally, the penial sheath ends at the point where the circular muscles of the atrium and the longitudinal ones of the sheath are joined. In *Ceratodrilus* there is a distinct outer indentation at this point; in other words, the penial sheath is less in diameter than the atrium (figs. 12 and 14). The penial sheath is composed of two muscle layers, the outer longitudinal one mentioned and an inner circular layer which may be derived from that of the atrium, but which are continuous with the muscle layer of the ejaculatory duct. This inner layer of muscle cells forms strands which traverse the space between the sheath and the penis and attach to the latter, serving, one supposes, to withdraw the penis (figs. 3 and 6).

The penis is a continuation of the lining epithelium of the ejaculatory duct and when completely withdrawn into the penial sheath is folded several times in the ectal part of the sheath (fig. 6), but may be completely everted to form a rather membranous structure somewhat

expanded at the outer end (fig. 7).

Whether the eversible penis of *Cirrodrilus* is like that of *Ceratodrilus* cannot be determined without a direct comparison, but Yamaguchi's figure (1934:195) shows the bursa and penis of *Stephanodrilus* [= *Cirrodrilus inukaii*] to be rather like that of *Ceratodrilus* except for the shortness of the penial sheath which is simply the ental part of the atrium.

THE FEMALE REPRODUCTIVE SYSTEM. As remarked above, the female reproductive system proper of *Ceratodrilus* is not noticeably different from that of other branchiobdellids.

SPERMATHECA. The spermatheca of *Ceratodrilus* is a large organ. The bursal part consists of an inturning of the body wall to form a narrow canal of no great extent (fig. 8) lined with an epidermis continuous with and similar to that of the body wall. The spermathecal duct, which is narrow in such species as *Cambarincola macrodonta* Ellis (Holt and Hoffman, 1959: 101), is quite thick in *Ceratodrilus* and constitutes roughly half the length of the entire organ. It is lined with very tall glandular cells whose outer ends, which project into the lumen of the duct, are separated from each other. The nuclei of all these cells are located basally. This part of the spermatheca is enclosed by two muscle layers; an outer circular one and an inner longitudinal one. The spermathecal duct passes over into the spermathecal bulb without any increase in diameter of the bulb over the duct part of the organ (table 3); indeed in *C. thysanosomus* the bulb seems to be slightly less in total diameter than the duct, while the reverse may be true for *C. ophiorhysis*. The great increase in the diameter of the lumen of the bulb is accounted for by the absence of the longitudinal layer of muscles, the reduction in size of the outer circular muscle cells and the great decrease in the height of the cells of the lining epithelium which here are flattened (fig. 8). Generally the lining epithelium of the spermathecal bulb appears to be simply that of a lining epithelium, but in one specimen of *C. thysanosomus* these cells appear glandular, produce clear globules of what may be a secretory material at their free borders and are ciliated (fig 5). Apparently, this represents some sort of physiologically distinct phase in the activity of the spermatheca, since this condition was not observed in other individuals.

Entally, the spermatheca ends in a process in which no spermatozoa are found. The apparent length of this process is variable, but it is always present and the lining epithelium is of a different character from that of the bulb; the cells of this region are composed of a denser and darker staining cytoplasm. Frequently, the process is invaginated at its ental end (fig. 8) and that of *C. thysanosomus* may be slightly longer than that of *C. ophiorhysis*.

There are no specific differences which are clearly constant between the spermathecae of the species of *Ceratodrilus*. The organ is generally similar to that of other branchiobdellids, but differs in the diameter of the spermathecal stalk from that of *Cambarincola* and the ental process is not common in the genera known to the writer.

Much remains to be learned about *Ceratodrilus*. Many more collections are needed from the Snake River basin and nearby regions. Nothing is known of the ecology of the animals. Much more study of the range of morphological variability of *C. thysanosomus* should be done and its distribution in the relict streams of the Great Basin studied in detail. It is hoped that this report of what is known about this interesting genus will encourage workers with a ready access to these regions to investigate some of these problems.

SUMMARY

The history of previous treatments of the genus is reviewed and Hall's generic name, *Ceratodrilus*, is revived. *Ceratodrilus* is separated from *Cirrodrilus* Pierantoni by the presence of four instead of eight peristomial tentacles; by the presence of a prostate in the form of a prostatic bulb; by the deferent ducts entering the spermiducal gland at its ental end instead of along the midlength of the organ; by the absence of a median duct of the spermatheca; and by the presence of a common opening instead of paired ones of the anterior nephridia. A revised diagnosis of *C. thysanosomus* Hall and a diagnosis of *C. ophiorhysis*, n. sp., are presented and compared. The anatomy of the genus is discussed with particular emphasis placed on characters which vary from one group of branchiobdellids to another. Terms applicable to the branchiobdellid reproductive systems are defined and some new ones introduced.

LITERATURE CITED

- Ellis, Max M. 1912. A new discodrilid worm from Colorado. Proc. U. S. Nat. Mus. 42: 481-486.
- Goodnight, C. J. 1940. The Branchiobdellidae of North American crayfishes. Ill. Biol. Monogr. 17(3): 1-71.
- Hall, M. C. 1914. Description of a new genus and species of the discodrilid worms. Proc. U. S. Nat. Mus. 48: 187-193.

- Holt, P. C. 1949. A comparative study of the reproductive systems of *Xironogiton instabilus instabilus* (Moore) and *Cambarincola philadelphica* (Leidy) (Annelida, Oligochaeta, Branchiobdellidae). Jour. Morph. 84(3): 535-572.
- , 1953. Characters of systematic importance in the family *Branchiobdellidae* (Oligochaeta). Va. Jour. Sci., 4(2): 57-61.
- , 1955. A new branchiobdellid of the genus *Cambarincola* (Oligochaeta, Branchiobdellidae) from Kentucky. Jour. Tenn. Acad. Sci. 30(1): 27-31.
- , and R. L. Hoffman. 1959. An emended description of *Cambarincola macrodonta* Ellis with remarks on the diagnostic characters of the genus (Oligochaeta, Branchiobdellidae). Jour. Tenn. Acad. Sci. 34(2): 97-104.
- Moore, J. P. 1894. On some leech-like parasites of American crayfish. Proc. Acad. Nat. Sci. Phila. 45(for 1893): 419-428.
- , 1895. The anatomy of *Bdellodrilus illuminatus*, an American discodrilid. Jour. Morph. 10: 497-540.
- Pierantoni, V. 1905. *Cirrodrilus cirratus*, n.g.n.sp. Parasita dell' *Astacus japonicus*. Ann. Mus. Zool. Univ. Napoli. N. S. 1(31).
- , 1906. 2 nuovi discodrilidi del Giappone e della California. Ann. Mus. Zool. Univ. Napoli. N. S. 2(11).
- , 1912. Monografia dei Discodrilidae. Ann. Mus. Zool. Univ. Napoli. N.S. 3(24).
- Stephenson, J. 1930. The Oligochaeta. Oxford.
- Yamaguchi, H. 1932a. On the genus *Cirrodrilus* Pierantoni, 1905, with a description of new *Branchiobdella* from Japan. Ann. Zool. Japan. 13(4): 361-367.
- , 1932b. Description of a new branchiobdellid, *Carcinodrilus nipponicus*, n.g.n.sp. Jour. Fac. Sci. Hokkaido Imp. Univ. 2(ser. 6) (1): 61-67.
- , 1932c. A new species of *Cambarincola*, with remarks on spermatid vesicles of some branchiobdellid worms. Proc. Imp. Acad. 8(9): 454-456.
- , 1933. Description of a new branchiobdellid, *Cambarincola okadai* n. sp., parasitic on American crayfish transferred into a Japanese Lake. Proc. Imp. Acad. 9(4): 191-193.

- . 1934. Studies on Japanese Branchiobdellidae with some revisions on the classification. Jour. Fac. Sci. Hokkaido Imp. Univ. 3 (ser. 6) (3): 177-219.

EXPLANATION OF PLATES

All figures, except fig. 1, which is adapted from Yamaguchi (1934: 194) and fig. 2, were drawn with the aid of a camera lucida.

Legend. — *a*, atrium; *b*, bursa; *cp*, cephalic tentacles; *dd*, deferent duct; *ejd*, ejaculatory duct; *enp*, ental process of spermatheca; *esg*, lining epithelium of spermiducal gland; *j*, jaw; *jn*, junction of nephridial outlet ducts; *np*, nephridiopore; *op*, oral papillae; *p*, penis; *pb*, prostatic bulb; *ps*, penial sheath; *sb*, spermathecal bulb; *sd*, spermathecal duct; *sg*, spermiducal gland; *spb*, spermathecal bursa.

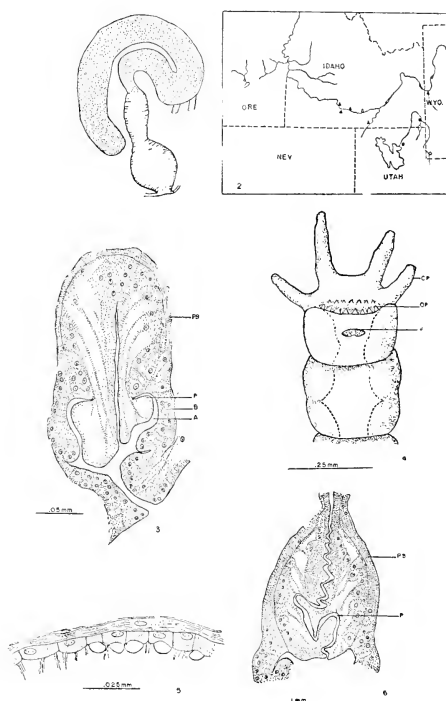


Plate I

Explanation of Figures

1. Male deferent apparatus of *Stephanodrilus inukaii*, after Yamaguchi (1934:194).
2. Distribution of *Ceratodrilus*. Circles indicate records for *C. thysanosomus*; triangles records for *C. ophiorhysis*. Solid figures indicate Holt's records; open ones, Goodnight's.
3. Oblique section of penial sheath, penis and atrium of *C. ophiorhysis*.
4. Ventral view of head of *C. ophiorhysis*.
5. Portion of wall of spermathecal bulb of *C. thysanosomus*.
6. Longitudinal section of penial sheath and penis of *C. thysanosomus*.

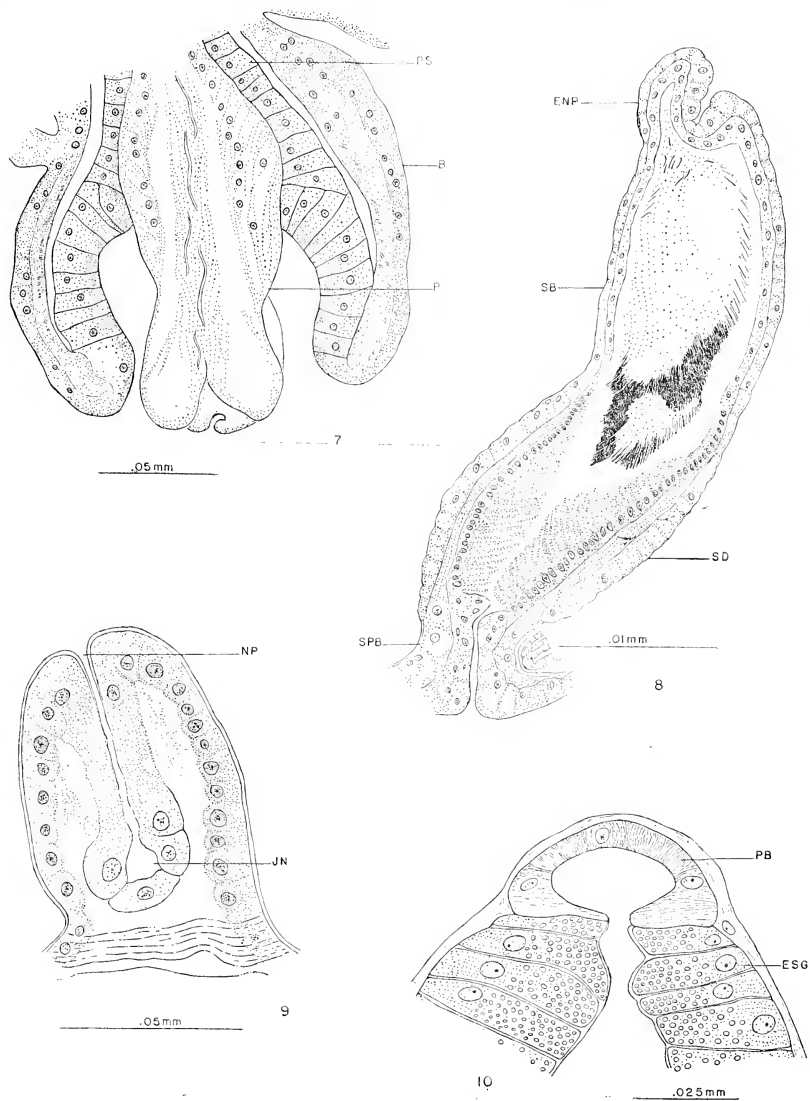


Plate II

7. Longitudinal section of everted bursa and penis of *C. thysanosomus*.
8. Longitudinal section of spermatheca of *C. ophiorhysis*.
9. Longitudinal section through the nephridiopore of *C. thysanosomus*.
10. Section through prostatic bulb and portion of spermiducal gland of *C. ophiorhysis*.

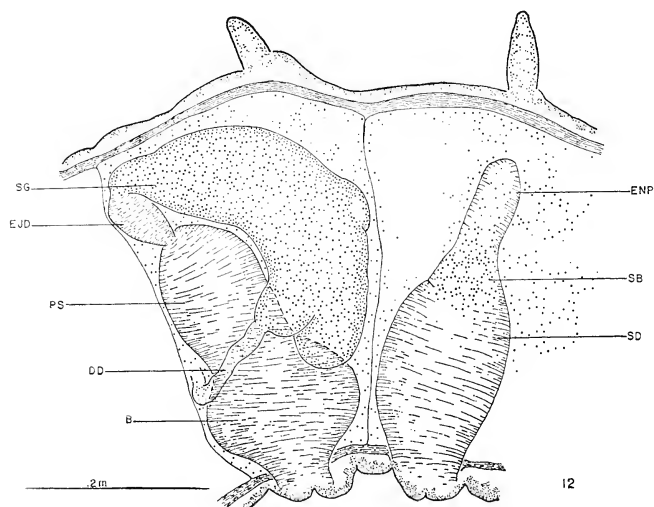
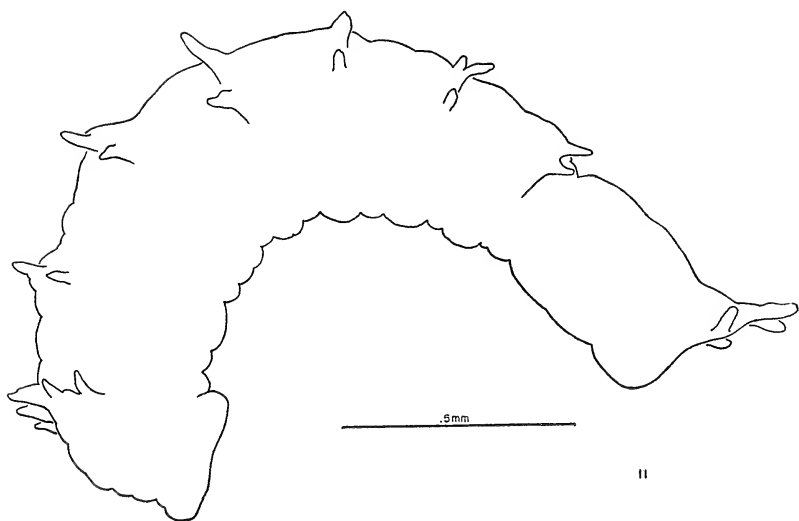


Plate III

11. Outline drawing of *C. thysanosomus*.
12. Lateral view of reproductive organs in segments v and vi of *C. thysanosomus*.

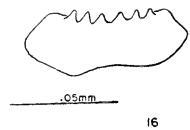
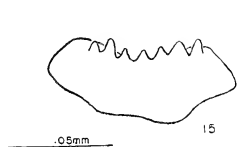
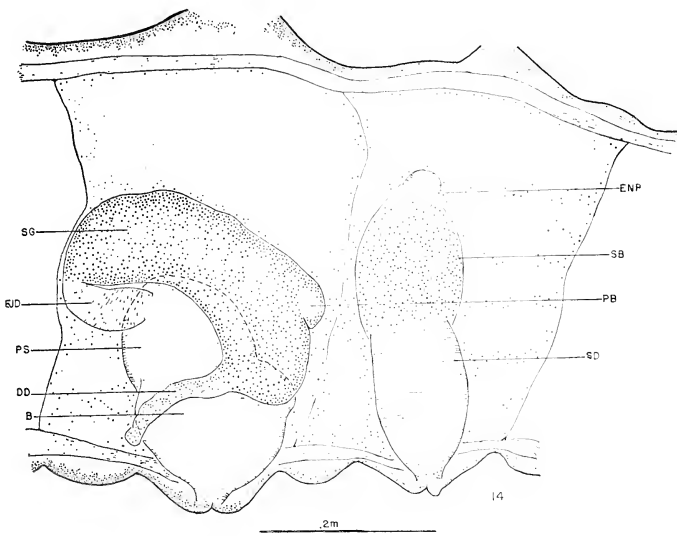
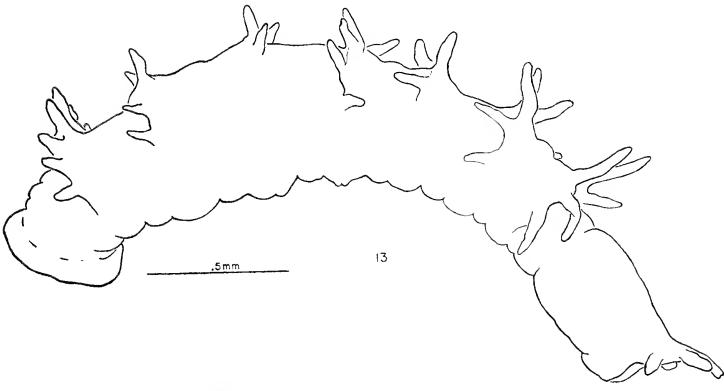


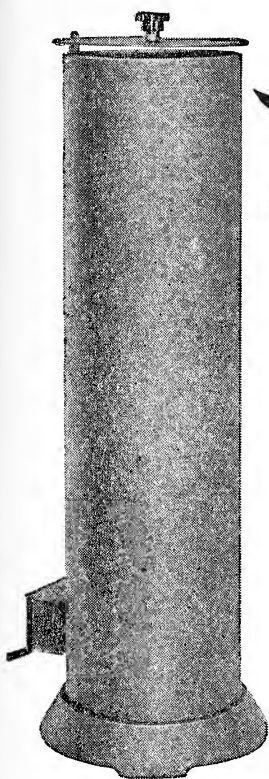
Plate IV

- 13. Outline drawing of *C. ophiorhysis*.
- 14. Lateral view of reproductive organs of *C. ophiorhysis*.
- 15. Upper jaw of *C. ophiorhysis*.
- 16. Lower jaw of *C. ophiorhysis*.

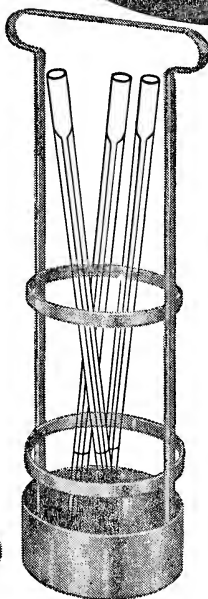
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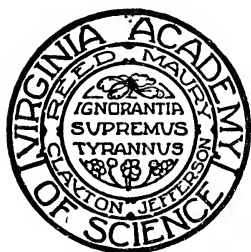
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Virginia Academy of Science

Program

OF THE
Thirty-Eighth Annual Meeting
RICHMOND, VIRGINIA



May 11-14, 1960

General Program Of The 38th Annual Meeting

EXHIBITORS. MEZZANINE, HOTEL JEFFERSON

WEDNESDAY, MAY 11, 1960

- 4:00 p.m. to 10:00 p.m. Registration for Junior Academy Members and Participants in the Science Talent Search. Ball Room
- 5:00 p.m. to 10:00 p.m. Arrangement of Exhibits. Ball Room
- 8:00 p.m. Virginia Junior Academy of Science Committee Meeting. Confederate Room

THURSDAY, MAY 12, 1960

- 8:00 a.m. to 10:00 p.m. Registration and arrangements of Exhibits. Ball Room
- 9:00 a.m. Meeting of Science Exhibit Judges. Empire Room
- Meeting of Science Talent Search Judges. Flemish Room
- 9:30 a.m. Meeting of Sponsors, Exhibitors, and Science Talent Search Participants and Judges, Empire Room
- 10:00 a.m. to 12:15 p.m. Finalists of Talent Search meet with Chairman and Interviewers. Dining Room A, Rebel Room, Dominion Room, Confederate Room, Randolph Room
- 1:15 p.m. to 3:00 p.m.
- 10:00 a.m. to 12:15 p.m. Judging of Science Exhibit Contest. (Encouragement of Juniors at their Exhibits.) Ball Room
- 1:15 p.m. to 3:00 p.m.
- 1:00 p.m. Section of Science Teachers. Washington Room
- 2:00 p.m. Meeting of the Council, Glasgow House, One West Main Street

3:00 p.m.	Business Meeting of Junior Academy of Science. Empire Room
4:30 p.m.	Meeting of Section Editors. Confederate Room
5:30 p.m.	Meeting of Junior Academy of Science Committee. Empire Room
8:00 p.m.	Annual Academy Conference. Empire Room

FRIDAY, MAY 13, 1960

8:30 a.m. to 10:00 p.m.	Registration, Lobby, Jefferson Hotel
9:00 a.m.	Section Meetings. See the detailed Section Programs for the time Schedule of Papers.
	Agricultural Science Section — Washington Room
	Astronomy, Mathematics, and Physics — Friday: Intermediate Room. Second Floor, Educational Building, Second Baptist Church, 7 West Franklin Street. Saturday: Assembly Room, Second Floor, Y.M.C.A.
	Bacteriology — Randolph Room
	Biology — Empire Room
	Chemistry — Flemish Room
	Education — Dining Room A
	Engineering — Y.M.C.A. Game Room
	Geology — Blue Room, Educational Building, Basement Second Baptist Church, 7 West Franklin Street
	Medical Science — Junior Department, Rear of Second floor Educational Building, Second Baptist Church, 7 West Franklin Street
	Psychology — Dominion Room and Confederate Room
	Statistics — Monticello Room

- 9:30 a.m. to 11:00 a.m. Coffee Hour — Academy Members, wives and Guests. Hostesses will be glad to assist the ladies in their plans for the day. Mezzanine, Hotel Jefferson
- 12:00 noon to 2:00 p.m. Virginia Junior Academy of Science Assembly Room, Basement, Sanctuary Building, Second Baptist Church (See program for Junior Academy)
- 12:15 p.m. to 1:15 p.m. Recess for Luncheon
- 1:30 p.m. Section Meetings
- 6:00 p.m. to 8:00 p.m. Recess for Dinner
- 8:00 p.m. Virginia Academy of Science Assembly. Ball Room
- Welcome to Academy — Colonel Fitzroy, Administrator of the University Center in Virginia
- Short Business Meeting, Election of Officers
- Presentation of the J. Shelton Horsley Research Award
- Guest Speaker: Dr. Harry F. Harlow, Professor of Psychology, University of Wisconsin and Past President of the American Psychological Association
- Subject: "A Theory of the Development of Affection in Primates."
- The General Public is invited to attend

SATURDAY, MAY 14, 1960

- 9:00 a.m. Section Meetings
- 10:00 a.m. Meeting of the Council of the Academy. Glasgow House, One West Main Street

Program Of The Virginia Junior Academy Of Science

WEDNESDAY, MAY 11, 1960

- 4:00 p.m. to 10:00 p.m. Registration and Arrangement of Exhibits. Ballroom. (Report to Registration and Assignment tables).
- 8:00 p.m. Virginia Junior Academy of Science Committee meeting, Confederate Room.

THURSDAY, MAY 12, 1960

- 8:00 a.m. — 10:00 a.m. Registration and Arrangement of Exhibits. Ballroom. (Report to Registration and Assignment tables)
- 9:00 a.m. — 9:30 a.m. Meeting of Science Exhibit Judges. Empire Room
- 9:00 a.m. — 9:30 a.m. Meeting of Talent Search Judges. Flemish Room
- 9:30 a.m. — 10:00 a.m. Meeting of Sponsors, Exhibitors, Science Talent Participants and Judges. Empire Room
- 10:00 a.m. Meeting of Club Sponsors. Empire Room
- 10:00 a.m. to 12:15 p.m. Finalists for Talent Search meet with Chairman and Interviewers. Dining Room A, Rebel Room, Confederate Room, Dominion Room and Randolph Room
- 1:15 p.m. to 3:00 p.m.
- 10:00 a.m. to 12:15 p.m. Judging of Science Exhibits. Ballroom
- 1:15 p.m. to 3:00 p.m.
- 3:00 p.m. Business Meeting of Virginia Junior Academy of Science. Empire Room

- 4:30 p.m. Virginia Junior Academy of Science Committee meeting. Dominion Room
- 8:00 p.m. to 10:30 p.m. Dance and Social Hour. White Students — Student Union, Medical College of Virginia. Colored Students — Virginia Union University

FRIDAY MAY 13, 1960

- 9:00 a.m. Participation in the Senior Academy Section Meetings
- 12:00 noon to 2:00 p.m. Virginia Junior Academy of Science Assembly and Awards Hour. Assembly Room, Second Baptist Church, 13 West Franklin Street. Guest Speaker: Dr. Vincent Schaefer, Consultant, Schenectady, New York
- 2:30 p.m. Exhibits may be dismantled

Section Of Science Teachers

A. B. Niemeyer, Jr. — *Chairman*
Virginia Ellett — *Chairman Elect*
Robert Horne — *Secretary*
Alan Mandall — *Section Editor*

THURSDAY, MAY 12, 1960. 1:20 P.M. WASHINGTON ROOM

THEME: "Recent Advancements in Science Teaching in Virginia High Schools."

1:00 — 1:20 — Business Session

1. 1:20—1:40—On The State Level —
Franklyn Kizer; Assistant Supervisor of Secondary Education
2. 1:40—2:00—From Augusta County
S. G. Stewart — Director of Instruction

3. 2:00—2:20—From Fairfax County
William S. Graybeal — Director of Secondary Education
4. 2:20—2:40—From Richmond City
L. D. Adams — Assistant Superintendent
5. 2:40—3:00 From Norfolk County
M. E. Alford — Assistant Superintendent

Section Of Agricultural Science

Current Officers (1959-60):

Maurice B. Rowe, III, *Chairman*

Wm. H. Brittingham, *Vice-Chairman*

Carl W. Allen, *Secretary*

Paul B. Siegel, *Section Editor*

FRIDAY, MAY 13, 1960, 8:30 A.M. WASHINGTON ROOM

- 8:30 Call to order by Chairman. Announcements and Committee Appointments
1. 8:45 Photoperiodism in Turkeys.
A. T. Leighton, Jr.; *Virginia Polytechnic Institute*
 2. 9:00 Susceptibility of Three Breeds of Chickens to Blackhead.
E. E. Lund; *Animal Disease and Parasite Research Division, Agricultural Research Service, Beltsville, Maryland*
 3. 9:15 A Modified Extraction-Titration Test for Detecting Rancidity of Milk and Cream.
W. K. Stone and P. M. Large; *Virginia Agricultural Experiment Station*
 4. 9:30 The Effect of Dietary Sodium Bromide Level upon the Rats' Growth and Carcass and Liver Bromide Levels.
Russell F. Miller and Janet M. Paulsen; *Virginia Agricultural Experiment Station*
 5. 9:45 Season and the Blood Picture of Sheep and Goats.
Lubow A. Margolena; *Animal Husbandry Division, Agricultural Research Service, Beltsville, Maryland*

6. 10:00 Genetic Parameters Concerned with Feed Efficiency in Full Fed Beef Cattle.
James A. Gaines; *Virginia Polytechnic Institute*
- 10:15 Break
7. 10:25 The Effect of Various Levels of Lysine in the Diet on Muscle Development and on the Various Blood Phenomena of Growing Swine.
G. M. Cahilly, R. F. Kelly, C. C. Brooks, and P. P. Graham; *Virginia Agricultural Experiment Station*
8. 10:40 Effectiveness of Three Management Systems for the Control of Internal Parasites in Lambs.
J. H. Turner, K. C. Kates, I. Lindahl, G. E. Whitmore, and F. D. Enzie; *Animal Disease and Parasite Research Division, Agricultural Research Service, Beltsville, Maryland*
9. 10:55 Guest speaker, Edward M. Hoshall, Chief Chemist, Food Additives and Pesticide Residues. *Baltimore District, Food and Drug Administration*
10. 11:35 Pesticide Residues.
James F. Eheart, P. H. Massey, Jr., E. C. Turner, and Jean Dickinson; *Virginia Agricultural Experiment Station*
11. 11:50 Calcium Sources for Peanuts.
D. L. Hallock; *Virginia Agricultural Experiment Station, Holland*
- 12:00 Adjourn for Lunch.
12. 1:15 The Effect of Soil Component on the Development and Survival of Sting Nematode.
Lawrence Miller; *Virginia Agricultural Experiment Station, Holland*
13. 1:30 Two Recent Developments of Great Significance in Corn Growing.
W. W. Moschler; *Virginia Agricultural Experiment Station*
14. 1:45 Detection of Seed Treatment.
C. F. Bruce and W. F. Crosier; *Virginia Department of Agriculture*
15. 2:00 The Soybean Cyst Nematode: A New Virginia Pest.
W. H. Matheny; *Virginia Department of Agriculture*
16. 2:15 Ammonium in Certain Virginia Soils.

C. I. Rich; *Virginia Agricultural Experiment Station*

17. 2:30 Effectiveness of Phosfon as a Chemical Height-Retardant on Potted Chrysanthemums and Easter Lillies.
Charles R. Downing and Staley L. Felton; *Virginia-Carolina Chemical Corporation*
18. 2:45 The Identification of Paint Oils Via Gas-Liquid Chromatography.
W. L. Zielinski, Jr., W. V. Moseley, Jr., and R. C. Bricker;
Virginia Department of Agriculture
- 3:00 Break
19. 3:15 What Can an Agricultural Economist Contribute to Research in the Physical Sciences?
Ross V. Baumann; *Farm Economics Research Division, Agricultural Research Service, Washington, D. C.*
20. 3:30 The Role of Expectations in Agricultural Supply Response.
Olman Hee; *Statistical and Historical Research Agricultural Marketing Service, Washington, D. C.*
21. 3:45 Peanut Supply Functions and Their Implications for Program Policy.
D. Upton Livermore; *Virginia Polytechnic Institute*
22. 4:00 Using Time and Cost Techniques to Reduce Cost in Virginia's Egg Marketing Firms.
E. C. Garland, Jr.; *Virginia Department of Agriculture*
23. 4:15 Influence of Technological Development on the Handling of Virginia Grade-A Milk.
R. F. Hutcheson; *Virginia Department of Agriculture*
- 4:30 Business Meeting.

Section Of

Astronomy, Mathematics, And Physics

Robert C. Yates, *Chairman*

Andrew Robeson, *Secretary*

Irving G. Foster, *Section Editor*

Friday, May 13, 1960. Intermediate Room, Second Floor
Educational Building, Second Baptist Church, 7 West Franklin Street

9:00 Announcements and Remarks by the Chairman

1. 9:10 An Ultra-high Vacuum System for the Deposition of Thin Metallic Films.
Calvin O. Tiller, *Virginia Institute for Scientific Research*
2. 9:25 Structure of Ag Films Deposited on a Single Crystal of NaCl.
Billy W. Sloope, *University of Richmond* (Work done at Virginia Institute for Scientific Research)
3. 9:40 An Apparatus for Measuring the Angular Distribution of the Two-gamma Annihilation of Positrons.
William C. Doughty, *Hampden-Sydney College*
4. 9:55 Angular Correlation of Annihilation Radiation.
R. S. Cortesi, *University of Virginia*
5. 10:10 A Continuously Varying Cooling Stage for X-Ray and Optical Studies.
J. F. Wilkins and T. E. Leinhardt, *Virginia Polytechnic Institute*
6. 10:25 A Far Infrared Monochromator for Use at Low Temperatures.
Robert J. Bell and T. E. Leinhardt, *Virginia Polytechnic Institute*
7. 10:40 Uranium Uptake in Nuclear Emulsions.
R. E. Garrett, *Hollins College*
8. 10:55 Measurement of the Electron and other Small Charges by the Magnetic Balance Method.
J. W. Beams, *University of Virginia*

9. 11:10 Transversal Doppler Shift Using the Mossbauer Effect.
J. W. Beams and S. Berko, *University of Virginia*
10. 11:25 Molecular Weights.
R. D. Boyle and P. E. Hexner, *University of Virginia*
11. 11:40 Production of High Vacua with a Magnetically Supported Centrifuge.
C. E. Williams, *University of Virginia*
12. 11:55 Photoneutron Cross Sections for Cobalt and Manganese.
P. A. Fluornoy, R. S. Tickle and W. D. Whitehead, *University of Virginia*
- 12:10 to 1:15 Luncheon Recess
13. 1:15 Some Uses of Pulsed Neutrons in Reactor Physics.
L. S. Anthony, J. L. McClure and A. Robeson, *Virginia Polytechnic Institute*
14. 1:30 An Accelerator for Producing Neutron Pulses.
J. L. McClure, L. S. Anthony and A. Robeson *Virginia Polytechnic Institute*
15. 1:45 A Monte Carlo Analysis of Neutron Thermalization in Graphite.
P. A. Newman and W. B. Payne, *Virginia Polytechnic Institute*
16. 2:00 The Design and Construction of a Single Channel Time Analyzer.
Wm. D. Beasely and W. B. Payne, *Virginia Polytechnic Institute*
17. 2:15 A Millimicrosecond Time-of-Flight Neutron Spectrometer.
C. I. Hudson and W. S. Walker, *University of Virginia*
- 2:30 Fifteen Minute Recess
18. 2:45 Measurement of Internal Magnetic Fields in a Ferromagnet with Polarized Neutrons.
T. G. Williams, G. C. Cobb and H. O. Funsten, *University of Virginia*
19. 3:00 Pulse Shape Discriminating Counters for Fast Neutrons.
H. O. Funsten, G. C. Cobb and T. G. Williamson, *University of Virginia*
20. 3:15 Elastic Scattering of 3.4 Mev Polarized Neutrons in S,Cu, and Zn.
G. C. Cobb, H. O. Funsten and T. G. Williamson *University*

of Virginia

3:15 Business Meeting

3:30 Business Meeting

SATURDAY, MAY 14, 1960. ASSEMBLY ROOM, SECOND FLOOR, Y.M.C.A.

1. 9:00 The Theory of Elementary Process.
Claude Marmasse, *Hollins College*
2. 9:25 Scintillations of the Radio Signal from a Satellite.
J. D. Lawrence, Jr., *University of Virginia*
3. 9:40 Angular Scintillations of Radio Stars.
James P. Hollinger, *University of Virginia*
4. 9:55 A New Look at Perturbation in Celestial Mechanics.
D. Willard, *Virginia Polytechnic Institute*
5. 10:10 Atmospheric Phenomena at a Sunrise Total Eclipse of the Sun.
John W. Stewart, *University of Virginia*
6. 10:25 Recent High Pressure Studies of Solidified Gases.
James N. Boyd and John M. Stewart, *University of Virginia*
7. 10:40 Apparatus for the Measurement of the Magnetic Rotation Spectra of Free Radicals Produced by Flash Photolysis.
J. L. Detch, L. Goodfriend and F. R. Crownfield, Jr., *College of William and Mary*
8. 10:55 A Demonstration of Phase and Group Velocities using a Cathode Ray Oscilloscope.
F. R. Crownfield, Jr., *College of William and Mary*
9. 11:10 Use of a Shoe X-Ray Machine for an Undergraduate Laboratory in Atomic Physics.
J. W. Little, *College of William and Mary*
10. 11:25 An Undergraduate Nuclear Physics Experiment on the Spectrum of a Beta Emitter.
L. Rogon and J. L. Detch, *College of William and Mary*
11. 11:40 A General Physics Laboratory Experiment on the Balmer Series of Hydrogen.
R. E. Adelberger, *College of William and Mary*

Section Of Bacteriology

(Virginia Branch, Society of American Bacteriologists)

Quentin Myrvik, *President*

Catherine M. Russell, *Vice-President*

Wesley A. Volk, *Secretary-Treasurer*

P. Arne Hansen, *Section Editor*

FRIDAY, MAY 13, 1960 — Randolph Room.

11:00 Business Meeting

12:00 Recess

1. 1:50 Presentation of Scientific Papers
2. 2:00 Incidence of Bacterial Species Isolated from Urinary Tract Infections.
H. J. Welshimer, *Microbiology Department, Medical College of Virginia*
3. 2:20 A Technique for Procuring Lung Macrophages.
Eva Soto Leake, *Microbiology Department, University of Virginia, School of Medicine*
4. 2:40 Histobacteriology, the Study and Identification of Microorganisms in Fixed Tissue by Fluorescent Antibodies.
J. D. Marshall and P. Arne Hansen, *Armed Forces Institute of Pathology, Washington, D. C., and Microbiology Department, University of Maryland, College Park.*
5. 3:00 Tuberculostatic Activity of Alveolar Macrophages.
Shunsaku Oshima, *Microbiology Department, University of Virginia, School of Medicine.*
6. 3:20 The Use of Iodine for the Disinfection of Indoor Swimming Pools.
J. E. Faber, J. D. Marshall and William Campbell, *Microbiology Department and College of Physical Education, University of Maryland, College Park.*

7. 3:40 The Properties of a Strain of Herpes Simplex Virus Which Produces Unusually Large Multinucleate Giant Cells in Tissue Culture.
Clayton E. Wheeler, *Dermatology Department, University of Virginia, School of Medicine.*

Section Of Biology

Jesse C. Thompson, Jr.; *Chairman*

Grace Wiltshire, *Vice-Chairman*

Willie M. Reams, Jr.; *Secretary*

Walter S. Flory, Jr.; *Section Editor*

FRIDAY, MAY 13, 1960 — 9:30 A.M. — Empire Room.

1. 9:30 The Blessed Thistle (*Cnicus benedictus*, L.) in Virginia.
A. B. Massey; *Virginia Polytechnic Institute*
2. 9:45 A *Zephyranthes* Complex on the Mexican Plateau.
Raymond O. Flagg; *The Blandy Experimental Farm*
3. 10:00 A 60-chromosomed *Allium* from Texas.
W. S. Flory and Rina Varma; *The Blandy Experimental Farm*
4. 10:15 The Genus *Beaucarnea*: (1) Chromosomes and (2) Systematic Position
W. S. Flory and Rina Varma; *The Blandy Experimental Farm*
5. 10:30 Some Properties of a Growth Influencing Substance in Timothy Roots
Robert T. Brumfield; *Longwood College and Oak Ridge National Laboratory*
6. 10:45 Do We Need a Geobiotic Ethic
Joseph J. Shomon; *Commission of Game and Inland Fisheries*
7. 11:00 Preliminary Studies on the Feeding Response of Redwings to 27 Grain Sorghum Varieties
Paul W. Lefebvre; *Virginia Polytechnic Institute*
8. 11:15 Evaluating Rabbit Management Procedures by Pellet Counts
Alan S. Krug; *Virginia Polytechnic Institute*

9. 11:30 Developing a Technique for Sampling Browse Production on Deer Ranges
Jim B. Whelan; *Virginia Polytechnic Institute*
10. 11:45 Variations in the Crayfish *Cambarus montanus acuminatus*
Larry L. Farmer; *University of Virginia*
- 12:00 Section Business Meeting
11. 2:00 Invitation Paper. Regeneration in Insects
Dietrich Bodenstein; *University of Virginia*
12. 2:45 Resistance to DDT and Chlordane in the German Cockroach Following Discontinuance and Restoration of Selection
James McD. Grayson; *Virginia Polytechnic Institute*
13. 3:00 The Albinistic Isopods of the United States
Harrison R. Steeves, III; *University of Virginia*
14. 3:15 A Study of the Microenvironment in Two Contrasted Forest Floor Habitats
James K. Grimm; *Madison College*
15. 3:30 Gastrotrichan Studies at Mountain Lake Biological Station, Giles County, Virginia, June-August, 1958
Charles E. Packard; *Randolph-Macon College*
16. 3:45 Morphogenesis of PET/MCV Mouse Melanocytes
Willie M. Reams, Jr., and Stuart E. Nichols, Jr.; *Medical College of Virginia*
17. 4:00 The Effect of Na-L-Thyroxine on Viability and Regeneration of *Dugesia tigrina*
William L. Mengebier; *Madison College*
18. 4:15 Histological Observations on the Oviduct of *Cambarus longulus longulus*, Girard, 1852.
D. Hugh Puckett; *College of William and Mary in Norfolk*
19. 4:30 T-1824 Dye Light Absorption Characteristic in Deproteinized Plasma
Jack D. Burke; *University of Richmond*
20. 4:40 CO₂ Studies in the Horned Passalus
James R. Powell; *University of Richmond*

Section Of Chemistry

Mearl A. Kise, *Chairman*

W. Allan Powell, *Secretary*

Mearl A. Kise, *Section Editor*

FRIDAY, MAY 13, 1960—9:00 A.M.—Flemish Room, Jefferson Hotel

9:00 Announcements: Introductory Remarks

1. 9:15 Determination of Polyphenols in Tobacco.
Marvin D. Edmunds and W. Allan Powell; *Philip Morris Research Center and University of Richmond.*
2. 9:30 A Study of the Reducing Substances in Cigarette Smoke.
J. E. Wickham, Jr., J. C. Holmes, and J. J. Westbrook, III;
Philip Morris Research Center
3. 9:45 A Material Balance Study of A Burning Cigarette.
Elizabeth T. Oakley, Melvin B. Bennett, and J. C. Holmes;
Philip Moris Research Center
4. 10:00 The Determination of Boric Acid by Conductimetric Measurement.
Carol A. Penn and Helen L. Whidden; *Department of Chemistry, Randolph-Macon Woman's College*
5. 10:15 A Comparative Study of Available Titrimetric Methods for Uranium.
Gayle King and Helen L. Whidden; *Department of Chemistry, Randolph-Macon Woman's College*
6. 10:30 A New Spectrophotometric Method for the Determination of Microgram Amounts of Manganese.
Dwight O. Miller and John H. Yoe; *Pratt Trace Analysis Laboratory, Department of Chemistry, University of Virginia*
7. 10:45 Combustion of Elemental Boron.
Claude P. Talley; *Experiment Incorporated*
8. 11:00 Preparation and Properties of Massive Amorphous Elemental Boron.
Claude P. Talley, Lloyd E. Line, Jr., and Quinton D. Overton,

Jr., *Experiment Incorporated*

9. 11:15 Isolation and Characterization of Gnaphalicin, An Antibiotic Isolated from *Gnaphalium obtusifolium* (Rabbit Tobacco).
Samuel J. R. Gamble; *Department of Chemistry, Lynchburg College*
10. 11:25 Kinetics of the Hydrolysis of Nitrostyrenes.
Thomas I. Crowell; *Cobb Chemical Laboratory, University of Virginia*
11. 11:35 The Technique for the Continuous Measurement of the Vapor Phase Corrosion of Metals.
W. H. Jago and N. F. Murphy; *Department of Chemical Engineering, Virginia Polytechnic Institute*
- 11:50 Business Meeting
12. 1:00 Phase Solubilities in the System: Phosphoric Acid-Water-Tributyl Phosphate.
B. L. Doumas and N. F. Murphy; *Department of Chemical Engineering, Virginia Polytechnic Institute*
13. 1:15 Representation of Delay Powder Data.
Lewis B. Johnson, Jr.; *Research Laboratories for the Engineering Sciences, University of Virginia*
14. 1:30 The Binary System Sodium Acetate-Propionic Acid.
Robert Hall and Wilbert Chappell; *Department of Chemistry, Madison College*
15. 1:45 The Growth of Thin Films of Gamma-CuBr on Copper Single Crystals.
Kenneth R. Lawless and Robert H. Kean; *Cobb Chemical Laboratory, University of Virginia*
16. 2:00 Electron Microscope Studies of Thin Nickel Electrodeposits on Copper Single Crystals.
Lucille B. Gammon; *Virginia Institute for Scientific Research*
17. 2:15 Thermodynamics of Aqueous Phenols.
W. F. O'Hara and L. G. Hepler; *Cobb Chemical Laboratory, University of Virginia*
18. 2:30 Studies in the Synthesis of a Sesquiterpene Ring System.
Oscar R. Rodig and Norman J. Johnson; *Cobb Chemical Laboratory, University of Virginia*
19. 2:45 Some Indole Derivatives Related to Natural Products.

Walter H. Hartung and A. Garnett Richardson; *Department of Chemistry and Pharmaceutical Chemistry, Medical College of Virginia*

20. 3:00 The Preparation of Trialkyl Phosphorotrithioites and Their Cotton Defoliant Activity.
Mathias F. Kelly and William R. Smithey, Jr.; *Department of Research and Development, Virginia Carolina Chemical Corporation*
21. 3:15 Bromination Reactions of 2-Methyl-2,5-dihydrothiophene 1, 1-Dioxide and Some of its Simple Derivatives.
Robert C. Krug and James A. Rigney; *Department of Chemistry, Virginia Polytechnic Institute*
22. 3:30 Preparation of Some Cyclic Sulfone Derivatives by the Hydroboration Reaction.
Robert C. Krug and Donald E. Boswell; *Department of Chemistry, Virginia Polytechnic Institute*
23. 3:40 Reactions of Cis- and Trans-dyprones.
Landry T. Slade and Robert E. Lutz; *Cobb Chemical Laboratory, University of Virginia*
24. 3:55 Synthesis and Investigation of Hydrazidooxalic Acid.
Thomas P. Foley, Jr., Thomas C. Imeson, II, David N. Keyes, and James K. Shillington; *Department of Chemistry, Washington and Lee University*
25. 4:10 The Coupling of Grignard Reagents to Benzyl Systems.
Frank A. Vingiello, Sih-gwan Quo and John Sheridan; *Department of Chemistry, Virginia Polytechnic Institute*
26. 4:20 An Unusual Reduction Observed During the Course of a Grignard Reaction.
Frank A. Vingiello and Thomas Delia; *Department of Chemistry, Virginia Polytechnic Institute*
27. 4:30 The Synthesis of Some New 10-Substituted -aryl 1, 2-Benzanthracenes.
Frank A. Vingiello and Claude I. Lewis; *Department of Chemistry, Virginia Polytechnic Institute*

Section Of Engineering

O. R. Singleton, Jr., *Chairman*

Stuart B. Row, *Secretary*

R. M. Hubbard, *Section Editor*

FRIDAY, MAY 13, 1960, — 9:00 A.M. Y.M.C.A. Game Room.

1. 9:00 A Miniaturized Generating Electric Field Meter.
B. J. Gilpin, R. R. Humphris and F. E. Morse, *Division of Electrical Engineering, Research Laboratories for the Engineering Sciences, University of Virginia*
2. 9:15 An A. C. Ionization Chamber.
C. D. Broadbent, R. R. Humphris and W. P. Walker, *Division of Electrical Engineering, Research Laboratories for the Engineering Sciences, University of Virginia*
3. 9:30 A Low Level, High Frequency, D. C. Chopper.
E. W. Emt, G. C. Davies, J. D. Cooke and R. S. Ramsey, *Department of Electrical Engineering, University of Virginia*
4. 9:45 Detection of Radioactive Argon from the University of Virginia Reactor.
Jack K. Gilham, *Department of Nuclear Engineering, University of Virginia*
5. 10:00 Nuclear Design Analysis of a Thermionic Converter Reactor.
David J. Paul, *Department of Nuclear Engineering, University of Virginia*
6. 10:15 Performance Characteristics of the V.P.I. Argonaut Reactor.
E. Stam and A. Robeson, *Department of Physics, Virginia Polytechnic Institute*
7. 10:30 A Method of Transforming Concentrated Surface Forces into Continuous Surface Forces.
William Zirk and Mohammed Abdul Majud, *Department of Civil Engineering, University of Virginia*
8. 10:45 The Separation of Isotopes Using a Short-Bowl Ultracentrifuge.
Gernot Zippe, A. R. Kuhlthau and Robert L. Overstreet, *Division of Engineering Physics, Research Laboratories for the En-*

gineering Sciences, University of Virginia

9. 11:00 On the Motion of a Particle in a Free Vortex Centrifuge.
John E. Scott, Jr., *Department of Aeronautical Engineering, University of Virginia*
10. 11:15 The Analog Computer in Engineering Analysis.
J. P. Raney, *Department of Mechanical Engineering, University of Virginia*
11. 11:30 An Analog Study of the Stability of Flexible Missiles with Autopilot and Second-Order Control Response.
James B. Eades, Jr. and G. L. Smith, *Aeronautical Engineering Department, Virginia Polytechnic Institute*
12. 11:45 On the Simulation of the Electron Concentration Encountered by a Body During Re-entry to the Earth's Atmosphere.
J. N. Perkins and A. J. Russo, Jr., *Aeronautical Engineering Department, Virginia Polytechnic Institute*
13. 12:00 Propulsion System Requirements of the Manned Interplanetary Vehicle.
R. W. Truitt and P. R. Kurzhals, *Aeronautical Engineering Department, Virginia Polytechnic Institute*

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14. 1:15 Space Cabin Requirements of the Manned Interplanetary Vehicle.
R. W. Truitt and P. R. Kurzhals, *Aeronautical Engineering Department, Virginia Polytechnic Institute*
15. 1:30 The Effect of Chloride Ion on the Pitting of Inconel and Incoloy.
James A. Miller, W. A. Wilkinson and N. F. Murphy, *Department of Engineering, Virginia Polytechnic Institute*
16. 1:45 Neutron Flux Measurements by the Use of Thin Gold Films.
Arthur P. Deverill, *Department of Nuclear Engineering, University of Virginia*
17. 2:00 Neutron Flux Measurements with a Hydraulic Rabbit.
George H. Gordes and George A. Custer, *Department of Nuclear Engineering, University of Virginia*
18. 2:15 Design Factors of a Nitrogen Isotope Chemical Exchange Tower.
Carl A. Renfroe, D. A. Hayford and Fred W. Bull, *Depart-*

ment of Chemical Engineering, Virginia Polytechnic Institute

19. 2:30 Heat Transfer and Pressure Drop Performance of a Baffled Heat Exchanger in Cooling a Viscous Liquid.
Patrick H. DeHart, Jr., and Fred W. Bull, *Department of Chemical Engineering, Virginia Polytechnic Institute*
20. 2:45 Anomalies in the Operation of Oven Type Molecular Beam Sources.
Richardo Zapata, *Division of Astronautics, Research Laboratories for the Engineering Sciences, University of Virginia*
21. 3:00 The Generation of Molecular Beams from Shock Tube Sources and Associated Transient Phenomena.
Arthur C. Bruce, *Aeronautical Engineering Department, Virginia Polytechnic Institute*
22. 3:15 Analysis and Design of a Holweck Type Molecular Pump.
E. N. Sickafus, R. B. Nelson and R. A. Lowry, *Division of Engineering Physics, Research Laboratories for the Engineering Sciences, University of Virginia*
23. 3:30 Performance Data for Several Holweck Type Molecular Pumps.
R. B. Nelson, E. N. Sickafus and R. A. Lowry, *Division of Engineering Physics, Research Laboratories for the Engineering Sciences, University of Virginia*
24. 3:45 Non-equilibrium Molecular Dissociation of Air in a Hypersonic Nozzle.
J. N. Perkins, *Aeronautical Engineering Department, Virginia Polytechnic Institute*
25. 4:00 A Variation Problem in Space Mechanics.
James B. Eades, Jr., *Aeronautical Engineering Department, Virginia Polytechnic Institute*
26. 4:15 On a Solution to the Unsteady Laminar Boundary Layer.
H. A. Hassan, *Aeronautical Engineering Department, Virginia Polytechnic Institute*
27. 4:30 Quantum Mechanical Aspects of the Thermodynamic Properties of Gases.
R. W. Truitt, *Aeronautical Engineering Department, Virginia Polytechnic Institute*
28. 4:45 An Engineering Study of a Rotary Drum Crystallizer.
John C. Chaty, *Department of Chemical Engineering, University of Virginia*

29. 5:00 Engineering Exhibits presented by members of the Junior Academy of Science.

5:15 Business Meeting and Election of Officers

SATURDAY, MAY 14, 1960 — 9:00 A.M. — Y.M.C.A. Game Room.

1. 9:00 The Determination of Heat Transfer Characteristics for a Moving Bed System Composed of Air and Activated Carbon. William A. Barkley and Stuart B. Row, *Department of Chemical Engineering, Virginia Polytechnic Institute*
2. 9:15 The Use of High Rotational Speed Equipment to Complement Molecular Beam Studies in Gas Dynamics. H. J. Davis, Jr., *Division of Astronautics, Research Laboratories for the Engineering Sciences, University of Virginia*
3. 9:30 The Analysis of Ion Beams Using an R-F Mass Spectrometer. Hugh S. Landes, *Division of Electrical Engineering, Research Laboratories for the Engineering Sciences, University of Virginia*
4. 9:45 High Speed Drag on Rotating Cylinders at Very Low Pressures. J. H. Bodine, *Division of Astronautics, Research Laboratories for the Engineering Sciences, University of Virginia*
5. 10:00 A Technique for Measuring Capacity Changes of Two Insulated Hemispheres. B. J. Gilpin, R. R. Humphris and F. E. Morse, *Division of Electrical Engineering, Research Laboratories for the Engineering Sciences, University of Virginia*
6. 10:15 A Proximity Pickup with a Vacuum Tight Probe. W. M. Bland and W. H. Dancy, Jr., *Division of Engineering Physics, Research Laboratories for the Engineering Sciences, University of Virginia*
7. 10:30 Preparation of Plated Specimens for Microscopic Examination of Chrome-Steel Interface. Jamshed B. Francis and W. H. Dancy, Jr., *Division of Engineering Physics, Research Laboratories for the Engineering Sciences, University of Virginia*
8. 10:45 Satellite Orientation Using Magnetic Support Methods. Robert E. Russell, *Division of Electrical Engineering, Research Laboratories for the Engineering Sciences, University of Virginia*

9. 11:00 Deformation of a Symmetrically Unbalanced Hoop Rotating at High Speeds.
H. M. Parker, *Division of Theoretical Analysis* and W. C. Connolly, *Division of Engineering Physics, Research Laboratories for the Engineering Sciences, University of Virginia*
10. 11:15 The Soaking Effect — Apparent Drag Reduction on Bodies Held at Low Pressures for Extended Periods of Time.
J. E. May and A. R. Kuhlthau, *Division of Astronautics, Research Laboratories for the Engineering Sciences, University of Virginia*
11. 11:30 A Strength Criterion for Compacted Fine Grained Soils.
H. G. Larew, *Department of Chemical Engineering, University of Virginia*
12. 11:45 Rotational Hysteresis Losses in Nickel-Zinc Ferrites at Low Frequencies.
Ricardo Berner, *Division of Electrical Engineering, Research Laboratories for the Engineering Sciences, University of Virginia*
13. 12:00 Magnetostriction in Nickel-Zinc Ferrites.
Gerald S. Nurre, *Division of Electrical Engineering, Research Laboratories for the Engineering Sciences, University of Virginia*

Section Of Geology

J. L. Calver, *Chairman*

E. W. Ramsey, *Vice-Chairman*

R. S. Mitchell, *Secretary*

B. W. Nelson, *Section Editor*

FRIDAY, MAY 13, 1960 — 9:00 A.M. — BLUE ROOM, EDUCATIONAL BUILDING, BASEMENT SECOND BAPTIST CHURCH, 7 WEST FRANKLIN STREET.

9:00 Announcements

1. 9:10 Notes on the Geology of the Nile Delta and Adjacent Desert.
W. T. Parrott; *Virginia Department of Highways*
2. 9:30 Madison Canyon Earthquake — Montana, 1959.
E. W. Spencer; *Washington and Lee University*

3. 9:45 Mineral Paragenesis of the Meyers-L. Copenhaver Mines, Smyth County, Virginia.
R. C. Barnes and D. K. Grubbs; *University of Virginia*
4. 10:00 Retention of KCl by Halloysite.
G. W. Thomas; *Virginia Polytechnic Institute*
5. 10:20 Comments on Apatite from the Morefield Mine, Amelia County, Virginia.
E. H. McGavock and R. S. Mitchell; *University of Virginia*
6. 10:35 Geology of the Lexington Quadrangle, Virginia.
K. F. Bick; *Washington and Lee University*
7. 10:55 A Diabase Dike near Greenville, Augusta County, Virginia.
F. H. Campbell and J. M. Cole, Jr.; *University of Virginia*
8. 11:15 A Petrographic Study of Some Dikes in a Quarry in Blue Grass Valley, Highland County, Virginia.
E. K. Rader and V. S. Griffin, Jr.; *University of Virginia*
- 11:35 Business Meeting
- 12:00 Recess

Papers by Virginia Polytechnic Institute

National Science Foundation Undergraduate Participants

9. 2:00 Comments on the Objectives and Accomplishments of the National Science Foundation Program at the Virginia Polytechnic Institute.
B. N. Cooper
10. 2:10 Geology of Locust Cove Area, Smyth County, Virginia.
W. M. Eckroade
11. 2:25 Nolichucky Sedimentation and Stratigraphy in Part of Southwest Virginia.
J. Bryan
12. 2:40 Chemical Stratigraphy of Middle Ordovician Limestones in Rich Valley, Smyth County, Virginia.
E. L. Lee
13. 2:55 Canadian-Champlainian Disconformity near Chatham Hill, Virginia.
W. Fisher, Jr.

14. 3:10 Areal Geology of Part of Saltville Thrust Block near Saltville, Virginia.
J. T. Blankenship
15. 3:20 Gravity Survey Across the Saltville Thrust near Saltville, Virginia.
H. L. Welker
16. 3:40 Chatham Hill Limestone at the Type Locality, Smyth County, Virginia.
D. E. Hallinger
17. 3:55 Faunules of the So-called Maysville Division of the Martinsburg Formation, Smyth County, Virginia.
R. L. Sutherland

SATURDAY, MAY 14, 1960

Field trip under the direction of W. T. Parrott (Virginia Department of Highways) and R. S. Young (University of Virginia).

Section Of Medical Science

Edwin W. Pullen, *Chairman*

Eugene D. Brand, *Secretary*

W. Parker Anslow, Jr., *Section Editor*

FRIDAY, MAY 13, 1960 — 10:00 A.M. JUNIOR DEPARTMENT, SECOND FLOOR, REAR, EDUCATIONAL BUILDING, SECOND BAPTIST CHURCH, 7 WEST FRANKLIN STREET

1. 10:00 Particle Formation in Soluble Mitochondrial Extracts.
J. F. Albright; *Medical College of Virginia*
2. 10:15 Coacervation-like Phenomena with a Protein Component.
W. A. Mills; *Medical College of Virginia*
3. 10:30 Biophysical Studies of Skin Proteins.
E. R. Berry; *Medical College of Virginia*
4. 10:45 A Potentiometric Recorder for pH Measurement.
R. C. Williams; *Medical College of Virginia*
5. 11:00 Motion Pictures of Mating Behavior of a Protozoan Ciliate *Tetrahymena pyriformis* Rendered Amicronucleate by X-ray

Treatments.

C. C. Speidel; *University of Virginia School of Medicine*

6. 1:15 Metabolic Effects of m-dinitrobenzene in *Asperigillus Niger*.
Edwin S. Higgins; *Medical College of Virginia*
7. 11:30 Prothrombin and Factor V (Accelerator Globulin) in the Rat:
Influence of Age, Sex, and Intake of Fat Soluble Vitamins.
Susan J. Mellette, Martha G. Bourne and Walter O. Cowan;
Medical College of Virginia
8. 11:45 Some Physiological Effects of (-)-Cotinine, A Metabolite of
(-)-Nicotine.
Joseph F. Borzelleca, Edward R. Bowman and Herbert Mc-
Kennis, Jr.; *Medical College of Virginia*
- 12:00 Business Meeting.
9. 2:15 Mathematical Form of the Function Relating Body Specific
Gravity to Body Fatness in Mammals.
Grover C. Pitts; *University of Virginia School of Medicine*
10. 2:30 Acclimatization to Cold and the Thyroid.
Chalmers L. Gemmill; *University of Virginia School of Medicine*
11. 2:45 Studies of Cholinesterase by Potentiometric Techniques.
G. M. Angelton; *Medical College of Virginia*
12. 3:00 The Specificity of Some Hydrolytic Enzymes.
L. A. Mounter; *Medical College of Virginia*
13. 3:15 Effects of Total Pancreatectomy in Experimental Pancreatitis.
Max S. Rittenbury and R. Egahl; *Medical College of Virginia*
14. 3:30 Studies of the Toxic Factor in Experimental Hemorrhagic
Pancreatitis.
Max S. Rittenbury and L. A. Mounter; *Medical College of
Virginia*
15. 3:45 The Analogue Computer: A tool for biological and physical
Research.
F. H. Schmidt; *Medical College of Virginia*
16. 4:00 A High Intensity Pulsed Light Source for Retinal Burn Studies.
R. S. Ruffin, R. C. Williams and F. H. Schmidt; *Medical
College of Virginia*
17. 4:15 The Loss of Light Energy in the Retina and Choroid.
Walter J. Geerates, Guy Chan and R. C. Williams; *Medical
College of Virginia*

Section Of Psychology

John F. Hahn, *Chairman*

Robert A. Johnston, *Secretary-Treasurer*

Cyril R. Mill, *Section Editor*

FRIDAY MORNING, MAY 13, 1960 — 9:15 A.M. DOMINION ROOM.

Noble R. McEwen, *Section Chairman*

1. 9:15 Certain Time Relations in Serial Rote Learning.
Gene Wilson and Rosemary Hartman, *College of William and Mary*
2. 9:30 Individual Differences in Binary Pattern Recognition.
Dorothy W. Dyer and E. Rae Harcum, *College of William and Mary*
3. 9:45 Attensity Gradients in the Perception of Binary Patterns.
David Camp, *College of William and Mary*
4. 10:00 Further Experiment Concerning Dependency Contrast in Visual Detection and Recognition.
E. Rae Harcum, *College of William and Mary*
5. 10:15 Some Effects of Long-Continued, Low Intensity, Gamma Irradiation on the Rat.
Leonard E. Jarrard, *Washington and Lee University*
6. 10:30 Acquisition of Probabilistic Paired Associates, As a Function of S-R1, S-R2 Ratio and Blank Trials.
James H. Woods, *University of Virginia*
7. 10:45 INTERMISSION.
8. 11:00 Panel Discussion: Critical Issues Related to the White House Conference on Children and Youth.
Cyril R. Mill, *Dept. of Mental Hygiene and Hospitals*
Herbert Krueger, *State Dept. of Welfare and Institutions*
Herbert Ross, *Social Service Bureau, City of Richmond*
9. 12:30 Lunch — Committee Meetings.
William L. Dunn, *Session Chairman*

10. 2:00 An Experimental Investigation of Forgetting and Anxiety.
John H. Borghi, *College of William and Mary*
11. 2:15 Conditions Determining Short Term Retention in Sequential Tasks.
H. Ray Brackett, *University of Virginia*
12. 2:30 Work As a Measure of Motivation in Operant Conditioning.
Nelson Smith, *College of William and Mary*
13. 2:45 Bar Press Apparatus Suitable for Construction and Use by Students.
Peter Guthrie and David Camp, *College of William and Mary*
14. 3:00 Symposium: Sensory Deprivation, Clinical and Theoretical Implications.
Moderator, Robert G. Gibby, *Veterans Administration Hospital*
Contributors, Henry B. Adams, *Veterans Administration Hospital*,
Richard N. Carrera, *Veterans Administration Hospital*,
David Cooper, *Duke University*
15. 4:30 Business Meeting.
16. 5:30 Social Hour and Dinner.

SATURDAY, MAY 14, 1960 — 9:00 A.M. — DOMINION ROOM

Merton E. Carver, *Session Chairman for Section A*

17. 9:00 Distribution of Practice in Concept Formation.
James Crouse and Peter Guthrie, *College of William and Mary*
18. 9:15 The Secondary Reinforcing Value of Low Intensity Shock.
James F. Campbell, Jr., and Douglas K. Candland, *University of Virginia*
19. 9:30 The Evoked Electro cortical Potential and Its Relation to the Behavior Conditioning.
George Gerken, *University of Virginia*
20. 9:45 Interaction of Hunger and Estrus in the Rat.
Robert L. Rhyne, *University of Virginia*
21. 10:00 Discrimination Reaction Time to a Vibrotactile Display.
Raymond C. Brice, *University of Virginia*
22. 10:15 Electrical Stimulation of the Skin-On Purpose.
Robert H. Gibson, *University of Virginia*

1960 CONCURRENT SESSION, SATURDAY, MAY 14, 1960 — 9:00 A.M.
CONFEDERATE ROOM

Jacob Silverberg, *Session Chairman for Section B*

23. 9:00 The Nature of Aversive Stimuli.
L. S. Reid, *University of Virginia*
24. 9:15 Scaling of Motor Noises for Annoyance.
James H. Brown, *University of Virginia*
25. 9:30 The Development of Affectional Responses in Infant Dogs.
George J. Igel, *University of Virginia*
26. 9:45 Testing in Juvenile Courts — A Survey.
Ray Naar, *Juvenile and Domestic Relations Court of Richmond*
27. 10:00 Need Affiliation: Approach and Avoidance Aspects.
Richard N. Carrera, *Veterans Administration Hospital, Richmond*
28. 10:15 Mental Hospital Admission Rates as A Measure of the Extent of Mental Illness in Modern American Society.
Henry B. Adams, *Veterans Administration Hospital, Richmond*
29. 10:30 INTERMISSION.
30. 10:45 Business Meeting.
Cletus A. Cole, *President*
Frank W. Finger, *Vice-President*
Cora Lynn Goldsborough, *Secretary*
William L. Dunn, *Treasurer*

Section Of Statistics

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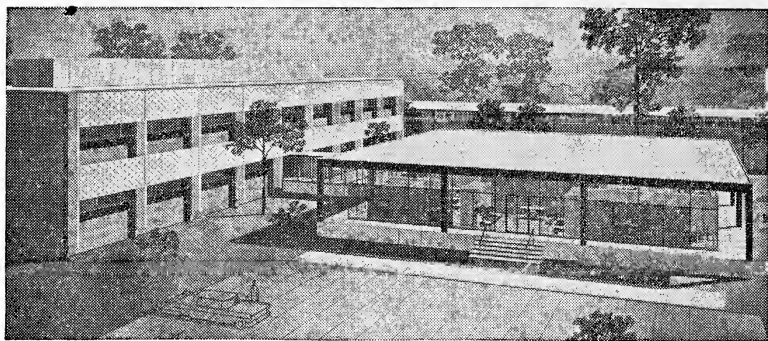
PROGRAM FOR ANNUAL MEETING FRIDAY, MAY 13, 1960 — 9:00 A.M.
MONTICELLO ROOM

1. 9:00 Introductory Remarks by the Chairman
2. 9:10 Some Further Studies on Detection of Defective Quantities.
Rolf E. Bargmann and Frederick Leroy Carter, Jr., *Virginia Polytechnic Institute*
3. 9:30 Some Compound Binomial Distributions.
Malcolm Turner, *Medical College of Virginia*
4. 9:50 Sequential Allocation of Patients in Clinical Trials (Preliminary Report).
Robert J. Taylor, *Virginia Polytechnic Institute*
- 10:10 Intermission.
5. 10:20 On the Combination of Errors in Agricultural Research.
N. R. Thompson, *Virginia Polytechnic Institute*
6. 10:40 The Measurement of Risk in Agricultural Production.
Paul H. Hoepner, *Virginia Polytechnic Institute*
7. 11:00 The Reliability and Cost Considerations of Systems with Spare Components.
Donald F. Morrison, *National Institute of Mental Health and Virginia Polytechnic Institute*
8. 11:20 Some Tests for Outliers.
Charles Quesenberry, *Virginia Polytechnic Institute*
9. 2:00 A Soybean Experiment Interpreted With Respect to Genetic Models.
Theodore W. Horner, Booz, *Allen Applied Research, Inc.* and Charles R. Weber, *Iowa State College*

10. 2:45 Business Meeting
11. 3:15 A Study of Soldier Preferences for Various Blends of Roasted and Ground Coffees in Three Strengths.
Elie Weeks, *Quartermaster Research and Engineering Field Evaluation Agency*
12. 3:35 Contributions to the Method of Paired Comparisons.
H. A. David, *Virginia Polytechnic Institute*
13. 4:05 Some Asymptotic Results in a Balanced Paired-Comparisons Experiment.
B. J. Trawinski, *Virginia Polytechnic Institute*

SATURDAY, MAY 14, 1960 — 9:00 A.M. MONTICELLO ROOM.

14. 9:00 Meteorological Applications of Power-Spectrum Analysis.
Ronald E. Walpole, *Roanoke College*
15. 9:20 Multivariate Analysis of Incomplete-Variables Designs.
Irene Monahan, *Virginia Polytechnic Institute*
16. 9:40 Some Contributions to the Evaluation of Pearsonian Distribution Functions.
John White, *Virginia Polytechnic Institute*
- 10:00 Intermission.
17. 10:10 The Prediction of College Success from Tests and High School Achievement.
John M. Long, *College of William and Mary in Norfolk*
18. 10:30 Optimum Allocation in Regression Split-Plot Experiments.
R. M. DeBaun, *American Cyanamid Corporation* and V. Chew, *U. S. Naval Weapons Laboratory*
19. 10:50 Conditional Distributions Arising from Variation of Parameters in a Non-Linear Response Function.
Max H. Myers and David C. Hurst, *Virginia Polytechnic Institute*



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Footnotes should be included in the body of the manuscript immediately following the reference, and set off by a dashed-line above and below the footnote content. Footnotes should be numbered consecutively from the beginning to the end of the manuscript.

Bibliographies (Literature Cited, References, etc.) should be arranged alphabetically according to author. Each reference should include the date, full title of the article, the name of the Journal, the volume, number (optional), pages, tables and figures (if any). For example: "Sniffen, Ernest W. 1940. Cobbles from the Pleistocene Terraces of the Lower York-James Peninsula Va. *Journ. Sci.*, 1 (8): 235-288 1 fig., 1 tab. Reference to the bibliographic citations should not be made by numbers. Instead, using the above citations, where a reference is desired: either "Sniffen (1940)", (Sniffen, 1940: 186)", or "Sniffen (1940) states that . . ."

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July, 1960

No. 3



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C O N T E N T S

	<i>Pages</i>
The Place and Price of Excellence. Jacques Barzum	113
The Fungus Flora of Agricultural Soils in Virginia	
I. Aquatic Phycomycetes. William W. Scott	125
News and Notes	131

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THE VIRGINIA JOURNAL OF SCIENCE

VOL. 11, NEW SERIES

July, 1960

No. 3

THE PLACE AND PRICE OF EXCELLENCE

JACQUES BARZUN

Provost and Dean of Faculties, Columbia University

Although there are many subjects in which I am sure you take an interest comparable to mine, I have chosen one which (as I hope) is particularly suited to your present concerns and also to the time. You are students, presumably engaged in studying; you are graduate students, who may soon become teachers; you are parents or shortly to become parents; you are citizens, whose votes and whose taxes are being, or going to be, solicited in the name of education. I am accordingly going to talk to you about education — or so it would seem. But as I have often said, talk about education bores me, so under guise of education I am going to talk to you about Intellect and Intellect of the kind that is rarest and most excellent. I am going to use the facts and the follies of education to talk to you about intellectual excellence.

The word *excellence* has a pleasing sound. But it has been a long time since we in the United States have heard it from anybody but an advertiser. We associate excellence with the products of industry, not only because we are told they are excellent, not only because the price we pay and the effort we make to obtain these artifacts seem to justify our hope of their excellence, but also and, I think, chiefly, because we are very sure that, being artifacts, those which are declared excellent will not incur the resentment of the others.

If this is true, it means that we are still very much alive to the idea that underlies excellence — the idea of excelling, of raising oneself so as to be better or greater than, or superior to, another. We are alive to this idea at large, but we do not like to apply it to persons. We suppress it in our social life and even in our private thoughts, because it seems to run counter to another idea that we cherish more stubbornly — the idea

*An address before the third convocation of the Graduate School of Cornell University. Published by Cornell University.

of equality. We find it repugnant to our political professions and our democratic manners that anyone should be believed in any better or greater than someone else, should know himself to be, or should act as if he were, in any way superior.

Very recently, however, a public report on the state of education, prepared for the Rockefeller Brothers' Fund and drafted under the direction of Mr. John Gardner, the head of the Carnegie Corporation, was issued with the title: "The Pursuit of Excellence." In the light of our ancient prejudice about the word, the use of that phrase seems to me to mark a turning point in the national opinion.

The phrase did not, of course, provoke the change. Rather, it confirmed the fact that the change was taking place. For the change is not merely in education, any more than it is a rediscovery of excellence in living beings after a long siege of confinement in dead things. To talk of excellence in connection with education is much more momentous than appears on the surface. For what does excellence in education or learning really refer to? It refers to intellect. To talk of excellence in education means to talk to the place of Intellect in the national life. And this is almost unheard of. Education with us has been for every good purpose, I will not say, *except* an intellectual purpose, but every good purpose *ahead* of an intellectual purpose. It has been for character, citizenship, health, social and individual adjustment, cultural assimilation, vocational aid, profitable friendships, marriage opportunities, and hobbies of distinction. The desire to raise the Intellect to new heights has not existed or been avowed. And we are still far from according Intellect a clear place; the Rockefeller Brothers' report seems to speak of it as if it were the same as creativity, which it is not; but even creativity they want to have thrive "in a context of concern for all." This is hedging: clearly we do not quite know what Intellect is, and what we do know we are afraid of. But we have at last come face to face with the fact that Intellect exists, and we mean somehow to come to terms with it.

The general public today probably thinks that the present agitation about education and the training of talents dates from the Russian success in launching rockets. But that is not so. The unrest and criticism came well before. Some of you will remember the reports of the President's Commission on Higher Education, the vogue of the book *Why Johnny Can't Read*, the mounting protest against so-called progressive methods, and the repeated exposures of folly and futility in our colleges and teachers' colleges. These and other like events show that the unassuming citizen has in the last few years been acquiring a new and well founded-worry.

Still earlier, there had been a good deal of quiet self-scrutiny by

professionals, usually encouraged by the foundations. The phrase "gifted child" emerged from these inquiries. The two most notable were perhaps the experiment in Portland, Oregon, which put the brightest children of all grades in speedier classes, and the advanced placement plan of acceleration devised by three colleges and three leading private schools in the East. The result of these pointed attentions that are paid to intellectual talent and have regard to the flight of time has been to make the American people recognize the inadequacy of their schools. The schools are inadequate because they culpably neglect the national resource of Intellect.

But this growing recognition, important as it is, does not bring us the remedy. Mere speed for the gifted is not enough. Larger doses of science and mathematics and American history will not change the strength and character of the instruction. If the diet is poor, undernourishment is not cured by larger amounts. Most important, inadequate arrangements cannot be bettered by people who have never found anything wrong with them. To put it more generally, the country is only beginning to perceive that its schools are not independent of the surrounding world: the world of parents, legislators, businessmen, journalists, and government officials. It is their ideas that have so far prevailed—ideas we need not scorn entirely for they have made good up to a point the adventure of mass education. In 1900 no one believed that the free, public, and compulsory high school could work. Well, it does not work very much or very well, but it works. Enough to be imitated, right now, by most of the countries of Europe, which are cheerfully repeating our early mistakes: our colleges and universities are also semi-mass institutions, remedial institutions for high school deficiencies; and to this Europe has not yet attained. We are at the point of farthest advance, and we are dissatisfied. Looking back on half a century of improvisation, we begin to see that some of our deepest convictions will have to change if our various schemes of improvement are to make a difference.

For the admitted evil—the inadequacy of school and college, in particular the wastefulness of the high school—is not one that can be removed by once more tinkering at the curriculum and patting a few gifted youths on the head. The notion of the gifted is true and useful, but it stops short of the response to Intellect which we must make if, hand in hand with the Rockefeller Brothers, we are not only to pursue excellence but occasionally to catch up with it.

At the moment, the gifted child stands in the public mind as an agreeable freak of nature, hitherto undervalued but well worth cultivating, indeed, almost as interesting as the retarded child. The two types balance each other like a pair of exotic vases on a mantelpiece. Both types, we think, are given us plainly marked by nature, fated to be what

they are. This may be true of the retarded; I am sure it is not true about the gifted. Their discovery, to themselves and by others, is not inevitable: it depends on the presence or absence of an intellectual atmosphere, on the awareness and acceptance of Intellect as a force. One of the most unexpected results of the Portland experiment was that, after a few months of the accelerated program, *those not in the program began to do better work*. Another startling result was that some notorious problem children, when given harder work to do, became good citizens. They had been bored, of course, and they had set fire to wastebaskets in order to have something to occupy their minds. Surely, in the light of such facts, we cannot consider the gifted child a natural species, which only requires the good treatment of a well-run zoo. We must on the contrary regard Intellect as potentially present in many individuals, and therefore as a power to be brought forth by making the school a place where intellectual effort and achievement are regarded as normal and necessary.

In the opposite outlook, which is still strong, I detect a secret desire to go on protecting equality, that is to say, to continue muffling excellence by showing, as is easy to do, that "Intellect isn't everything," that "to be smart isn't an unmixed blessing." Both propositions are true, but what have they to do with a school or university? As well argue in an opera house that "singing isn't all of life," and that Mozart's lot was not one of unmixed blessings. The equalitarian tradition, misapplied to our educational institutions is still so powerful that even in our present anxiety about places for the new generations in school and college, there lurks a hope that the strict measures being advocated may be only temporary. When our own rockets are cutting figure eights around the Russians', we can go back to quietly neglecting all normal, healthy, unintellectual American boys, and to lavishing expensive care on our true favorite, the slow mind.

You will not, I am sure, suspect me of wanting to deprive unfortunate boys and girls of the least help which lovingkindness bestows upon them. I dwell on their situation because the country dwells on it, and in so doing creates the contrast I want to make clear. As regards the mind, the American school or college is, generally speaking, not an educational, but a *philanthropic* institution. It tries to reduce competition and abolish failure; it is interested in the sociable personality rather than in the powers of Intellect; above all, it wants to preserve its own brand of happiness, in which everyone can—indeed must—participate. The worthy effort to make the handicapped feel that they are not outcasts but fully accepted members of the group—that effort is matched by another, directed at the gifted, superior, perhaps eccentric person, and intended to

assimilate him—literally to make him similar, to rub down his natural contours till he, too, is spherical and smooth and fit to serve as an interchangeable part in the social machine.

The proof that this characteristic effort of our schools springs from philanthropic feeling and not from hostility to special talents in that our schools and colleges make a great point of self-development and the diversity of aptitudes. Teachers are instructed to watch for individual differences and to let each student develop at his own pace. That is why the idea of intellectual competition has nearly disappeared, why in many places numerical grades have been replaced by verbal accounts written like psychological novelettes, why courses once taken and credited are good forever, regardless of evaporation, and why the word and the fact of failure are forbidden as scandalous and destructive. The ideal modern school, as we all know, is one in which contentment reigns because the young person is steadily pleased both with what he does and with the fact that others are pleased with him.

Now if we step from this little utopia to the training quarters of a successful athletic team, we find a very different state of affairs. The boys being trained are indeed the same that we encounter in any of a thousand classrooms in the country, but on the field their view of life is suddenly and radically altered. To begin with, a special seriousness pervades the atmosphere; the boys are not contented but visibly anxious. One feels the concentration of many strong wills on one object. There is little aimless action. Everyone takes advantage of the intervals of free time to jump, swing, flex the muscles, to practice throwing, catching, running. The coach and his assistants are as much interested as the classroom instructor in individual development, and they are keen watchers of diverse aptitudes. But they clearly have in mind for each individual a fixed idea of what constitutes performance. Far from letting each set his own pace, they hold him to a standard of their own choosing. If he does not meet it, he fails. Let me make the point clear: if he fails, he fails. There may be reasons for the failure, but no excuse, and certainly no consolation prizes and no verbalized psycho-apologies to the parents. On the contrary, I am told that the verbalizing of football coaches in moments of stress is far from apologetic.

The reason for this atmosphere of the training quarters is quite simple: the game is serious business. It engages the minds, hearts, and passions of all concerned, from coach to player to spectator. Training is therefore serious too. And when people are serious, no confusion is tolerated between performance and failure. No amount of desire to make up for the accidents of birth would induce anyone to give a slow-footed or slow-witted youth a place on the team. Our philanthropic, remedial impulses do not stretch quite so far. Indeed, we would consider any such

tempering of the mind either corrupt or stupid, and we would sack the coach. When, on the contrary, one of his atheletes is named to the All-American team, after the most solemn screening by the best official and unofficial judges in the country, all those interested are confident that they have witnessed from first to last the true way of discerning, developing and rewarding excellence.

The comparison I have just drawn, obvious as it is, contains the lesson American parents and teachers must learn. They must not say: "Yes, yes, we know it." They must believe it and act on it; they must do this no matter how strange it feels to believe what you say when you speak about education.

What the lesson tells us in familiar, unmistakable steps is what the definition of excellence implies: excellence means excelling, which means exerting the will to improve on nature according to rule. To squeeze high performance out of native ability, stern demands must be made by the talented on themselves, but these demands must come ultimately from the world that desires and rewards performance.

And yet, and yet . . . simple and persuasive as is this set of specifications, it is likely that something more has to be said before we are finally convinced. The contrast between classroom and playing field seems to accuse us too easily of being serious about games and frivolous about brains. Not all Americans are lifelong children enamored of sports. Not even all Europeans, whose sporting fever is by now worse than ours, have lost their senses. Why then do we hear of Europe's growing difficulty in maintaining intellectual standards—in their schools, universities, and professions? Since European attempts at mass education are much more recent than ours, we are forced to conclude that a connection exists between the neglect of intellectual excellence and the culture of a thorough-going democracy.

Ask anybody why it is right that tennis players should be weeded out by ruthless public competition and why it is also right that Johnny, who cannot spell, should merely be asked to try again a little harder. You will be told the object of tennis championships is simply to discover winners, whereas democratic schools have complex goals, of which supremacy in spelling is not even one. Schools are to keep children out of mischief and out of the labor market; they are to give the young of the country a common experience and a sense of their opportunities. The most taxing business of the modern school is to take the native and the foreign, the poor and the well-to-do social and induct them into the maze of industrial life. The school's primary aims are thus social and vocational rather than intellectual. And properly so, because the home is no longer an educational institution. It is at school that children must learn about

hygiene and safe driving, about the machinery of local government and the problems of adolescence. On top of this, the majority will want to learn shorthand and typewriting, home economics and the shop techniques known as industrial arts. What is now going on in schools of Western Europe is a reminder of our own past, an explanation of the natural law that, under the pressure of numbers, public schools will turn from being seminaries of Intellect to being social centers for multiple "adjustments."

Since this is true and since what we learned of the nature and conditions of excellence is also true, we would seem to have reached a deadlock. Or rather, our present desire to exploit the national resources of Intellect has brought us to see that there is a need, there is a place, for two markedly different institutions under the one name School. I also include under it college and university. We cannot do without the type of school or college I have described as a social center for assimilation and vocational guidance, and it is a safe guess that we shall continue to have it. The question is whether we want the other kind, the intellectual institution, which must take for granted much that the first kind is meant to impart. In other words, Intellect is a special interest requiring a special apparatus, a special nursery, if you will, though one which, to be effective, must not look like an isolation ward.

There is in fact no reason why the two types of school should not exist side by side in the same building, or on the same campus; nor why boys and girls with an intellectual bent should not share certain classes with others and attend special ones of their own. According to the National Defense Education Act (Public Law 85-864), the country needs linguists. Now, good linguists start young, and learned ones need to know many languages, including Latin, which the sales manager and agriculturist do not need. Why not, then, have the future linguists go to Latin class by themselves and join their friends, the farmer and businessman, in the government class? The way the president is elected and the principles of public hygiene are the same for all, whereas the concern with deponent verbs is not.

In theory and practice, then, the country's desire to see some of its young pursue intellectual excellence does not imply any new and invidious segregation. Such separation as must come is exactly like that required by the pursuit of athletic excellence. There is a training table reserved for the fit competitors and denied to the rest. No choice is imposed by force or privilege. Nature, taste, and sometimes family tradition dictate the path.

Fortunately for our intellectual renaissance, separations on intellectual grounds already exist or survive in rudimentary form. Certain high schools are noted for their excellence in art or in science or in the aca-

demic program generally. They serve communities where these accomplishments are valued. Certain colleges are renowned for their faculty and for the atmosphere of Intellect and the tradition of excellence which they have sustained for generations, since a time before mass education. The position of these schools and colleges makes them the natural leaders and best models of the School as an institution designed to nurture Intellect. They are free from close legislative control, free to choose their staff and students, free from irrelevant demands by militant and misguided taxpayers. All they have to contend with is lack of money and interference by militant and misguided parents and alumni. And by and large, thanks to intelligent and courageous leadership, they have resisted these errors born of meddlesomeness out of cultural conformity.

But this ever-present threat from the naive champions of thoughtless social pressures brings us back to the central issue: what should the cultural temper be to foster excellence, what price must we pay—quite apart from fees and gifts to endowment—to provide the favoring conditions?

Please note that I speak of providing the *favoring conditions*. Excellence cannot be bought or even asked for. You cannot without absurdity tell the waiter to bring you "an excellent cup of coffee." You can only ask him for a cup and hope that when tasted it will prove to be excellent. Similarly, the desire for intellectual excellence must begin soberly with the simple desire to establish and maintain the conditions of good work. Well, up to a point there is no lack of that desire. Those in charge of education and the public too, acknowledge the need for good equipment. Modern seats of learning can generally boast a superb *physique*. But this is evidently not enough, or we should not be at the critical juncture we are discussing here. No one has ever believed that the high quality of the training table was the sufficient cause of a winning team.

Nor in scholastic work is the cause exclusively good teachers. You can anticipate what I am about to say: the conditions that favor excellence cannot work singly. If we cannot have them all, we must at least have several, and these must be bound together by the atmosphere of concentrated effort and high seriousness which we saw in the training quarters, the discontent and the will to excel which we find wherever achievement is preferred to pious hopes.

Once established, that atmosphere is not difficult to sustain. What is hard is to begin. The world is still amazed at the remarkable outburst of great painters in the small towns of Renaissance Italy. A glance at the history shows that after a school had got under way, thanks to the coming together of two or three geniuses, talent sprang out of the ground and rushed to the masters' ateliers. The concentration of eager minds, the intensity of their rivalry, and the awareness of an enthusiastic public,

raised otherwise ordinary gifts to a higher power, to excellence. Atmosphere did it.

If, therefore, I am to answer literally the question implied in my title, the place of excellence is wherever there is the least glimmer of consciousness about its nature and requirements. If we grant that the country's main discovery and training of Intellect—for science, art and public life—can be carried on only in school and college, in certain dedicated schools and colleges, these places will be hampered and diminished if they are not surrounded by an atmosphere in which excellence is a familiar spirit. The home must, before all others, give it thought and room. How can a child or youth strive to excel in study, if his parents in their unguarded moments show their indifferences to Intellect, books, ideas, science, art—in a word, to the mind of man?

In the second place, the school or college must be staffed by men who recognize intellect when they see it, in one another and in their students. There is nothing automatic about this. Many teachers respect industry, politeness, and even flattery, who would be taken aback by an encounter with Intellect. For the young Intellect who is laboring to excel is quite different from the grind and the apple polisher trying to impress or to please. The test of Intellect is that its interest is genuine. It is indeed often necessary for a student to pretend an interest is genuine. It is indeed often necessary for a student to pretend an interest he does not feel: he *has* to do twenty calculus problems or write a 3000-word essay. But if he is ever to be educated, there must come a time when the problems grip him like a detective story and when he charges at the 3000-word limit because he has so much to say.

Intellect, in short, is a passion like any other. We who teach acknowledge this when we say of a student that he has at last caught fire. This is the very reason why the young Intellect must not be isolated. He must have others of his age similarly engrossed, or the fire will be that of the single stick—a spark, a bit of smoke, and then blackness. Nor is it enough for him to be encouraged at home and by the masters. The regular fellows, with palpable muscles and wearing the right kind of disreputable clothes, must also feel the nascent intellectual passions before any one youth—and by extension any school or college—can tread firmly and with characteristic zest on the path of excellence.

These being the geographical conditions, so to speak, what are the emotional costs? And first of all, do we, for the sake of Intellect have to give up, two centuries after Jefferson's *Declaration*, the doctrine of equality? A few weeks ago in *Time* magazine there appeared a report that a new college for science and engineering was being sponsored by a group of midwestern businessmen. Seeking excellence, they said in com-

menting on the new college, they were bound to confess their disbelief in equality. The doctrine was false and must be given up.

If correctly reported, the statement is a foolish one. Equality has nothing to do with merit, talent, or Intellect. Equality is a social and political assumption necessary to a certain form of government and congenial to the citizens of the United States. When we say that we are all equal, we mean precisely that the possession of wealth, or physical stature, or mental powers will make no difference in law and in manners. Equality in this sense is the result of a deliberate choice which requires self-control and aims at social simplicity.

Consequently, the discovery that men are not equal because one is tall and the other short, one stupid and the other bright, is irrelevant. Equality simply enjoins that these obvious differences shall make no difference in rights and privileges—it is the way a host treats his guests. You may say that Jefferson believed we were “created equal,” not simply endowed with equal rights. True, but if by analogy with a parent we try to imagine the point of view of the Creator, we see at once that our individual differences of talent or merit simply do not matter. That, if anything, is the meaning of the Fatherhood of God—in essence, stripped of local attributes, we are equal, if only because any virtue or power we may boast of implies no other. And who can add up all our traits and reach a total to compare with others? We are therefore equal in being incommensurable.

By the same token, when society incurs expense to develop intellectual power in those capable of it, the cost does not include giving up the principle of equality. Even now, the physician's education costs perhaps ten times as much as anybody else's. We think, rightly that he amply repays the social investment, and we know that his difference from the rest of us does not make him a member of a dangerous elite.

No, the emotional price we must pay for intellectual excellence is not the loss of social equality. It is a more personal and intimate loss, to which I alluded earlier in speaking of competition and in contrasting our present philanthropic schools with the educational ones we are beginning to desire. The price of excellence is the acceptance of pain, error, failure, even, I dare say, cruelty. This we are not used to. We love the young and want to see them happy and successful. We understand so well their confused feelings, their good intentions, their seemingly limitless possibilities of worth that we instinctively avoid dwelling upon their shortcomings. When rules are set up to guide their development and the rule makes them stumble, we bend the rule. This is undoubtedly proper at their first entrance into the world of obligation and responsibility, but carry it so far that the very idea of effort and the fundamental difference

between doing and failing to do are lost, forgotten alike by the teacher and by the student and absolutely unsuspected by the parent.

The moral is plain. It is hard enough to say: you have not done what you should have done; you have wasted your many chances; we have both warned and aided you, and you have given nothing of yourself; therefore find your own way outside the path that leads to praise and glory, and perhaps to wealth and power. Still harder, and indeed cruel, is to say: you have tried your best, but you are not made for the life you have chosen. Nature denied you the eye, hand and brain.

But, I submit that there is a cruelty far greater than either of these, an easy, indolent, irresponsible cruelty, which is to see the young, with their bursting energies and hopes and ambitions, flounder for lack of that special encouragement which is called Difficulty; to see them grow up full of fresh intelligence but with an Intellect like a garden full of weeds; to see them so naively pleased with their own accomplishments that the first stern demand, too long postponed, must be a shattering blow; to see them so accustomed to their own pace that they do not suspect the deep layers of grit and motherwit they hold within; to see them, finally, when well past college age, discover with shame and remorse what they might have been, if, instead of being neglected like mongrels or incubated like sickly growths, they had been urged and pressed and compelled to perform to the limit of their talents.

It is therefore not for the sake of turning out more engineers than Russia, not to manufacture as many linguists as the State Department wants, not to provide the colleges with enough teachers, it is not even to enable the du Pont Company to hire more chemists and produce the ultimate plastic which shall be food, clothing, and shelter all in one—it is not for these imperative or alluring prospects that this country must radically change its attitude toward scholastic excellence: it is simply and solely to put an end to the cruel injustice of letting rot, through protracted cowardice masquerading as kindness, the unimaginable endowments of youth and the tradition of Intellect which is their birthright.

THE FUNGUS FLORA OF AGRICULTURAL SOILS IN VIRGINIA

I. AQUATIC PHYCOMYCETES

WILLIAM W. SCOTT

Assoc. Prof. of Biology, V.P.I.
Blacksburg, Virginia

INTRODUCTION

It is generally accepted that the fungi constitute a significant group in the vast array of organisms known as the soil microbiota. Like many similar biological complexities, the details of the relationships, the activities, and the functions of these fungi are still obscure. Although similar studies have been made in certain areas of the United States, no previous attempt has been made to investigate the fungus flora of Virginia soils.

During the past four years, the writer and his students have made over 1500 collections for soil-inhabiting fungi from areas which include Montgomery County and five surrounding counties of southwestern Virginia. The methods of collection and isolation were essentially those described by Sparrow (1943) and Raper (1937), and were limited by intent to the aquatic phycomycetous fungi. The isolation procedure and single spore pure-culture techniques followed closely those described by Johnson (1956). An effort was made to obtain in pure culture for future studies all filamentous species. No attempts were made to obtain cultures of chytridiaceous species. All cultures are maintained in this laboratory and are available for future investigations.

The following fungi were identified during the present study. Citations for the specific binomials are given, but synonyms are not listed. No discussion of species limits is undertaken in this report for synonymous taxa, reference is made to Coker and Matthews (1937), Sparrow (1943), Johnson (1956), and Gilman (1957).

FUNGI COLLECTED

Chytridiales

Rhizophlyctis rosea (deBary and Woronin) Fischer, Rabenhorst Kryptogamen Fl., 1: 122. 1892.

Rhizophlyctis petersenii Sparrow, Proc. Amer. Phil. Soc., 78: 48. 1937.

Rhizophydium carpophilum (Zopf) Fischer, Rabenhorst Kryptogamen — Fl., 1: 95. 1892. Parasitic on the oogonia of *Saprolegnia* sp.

Rhizophydium pollinis-pini (Braun) Zopf, Abhandl. Nat. Gesell. Halle, 17: 82. 1887.

Rhizophydium sphaerotheca Zopf, Abhandl. Nat. Gesell. Halle, 17: 92. 1887.

Cladochytrium replicatum Karling, Amer. J. Bot., 18: 538. 1931.

Nowakowskiella hemisphaerospora Shanor, Amer. J. Bot., 29: 174. 1942.

Nowakowskiella ramosa Butler, Mem. Dept. Agr. India Bot. Ser. 1: 141. 1907.

Nowakowskiella elegans (Nowak.) Schroeter, In Engler und Prantl, Naturlichen Pflanzenfam., 1: 82. 1892.

Rozella achlyae Shanor J. Elisha Mitchell Sci. Soc., 58: 100. 1942. Parasitic in *Achlya* sp.

Rozella allomycis Foust, J. Elisha Mitchell Sci. Soc., 53: 198. 1937. Parasitic in the thalli of *Allomyces anomalus* Emerson.

Olpidium rhizophlyctidis Sparrow, Mycol., 40: 449. 1948.

Hyphochytriales

Hyphochytrium catenoides Karling, Amer. J. Bot., 26: 512-513. 1939.

Blastocladales

Catenaria anguillulae Sorokin, Ann. Sci. Nat. Bot. VI, 4: 67. 1876.

Allomyces arbuscula Butler, Ann. Bot. 25: 1027. 1911.

Allomyces javanicus Kniep, Ber. Deuts. Bot. Ges., 47: 211. 1929.

Allomyces anomalus Emerson, Lloydia, 4: 133. 1941.

Blastocladiopsis parva (Whiffin) Sparrow, J. Wash. Acad. Sci., 40: 53. 1950.

Monoblepharidales

Monoblepharella endogena Sparrow, Mycol., 45: 593. 1953.

Saprolegniales

Achlya dubia Coker, The Saprolegniaceae, p. 135. 1923.

- Achlya colorata* Pringsheim, Sitzungsber. Acad. Berlin, 1882: 889. 1882.
- Achlya americana* Humphrey, Trans. Amer. Phil. Soc. 17: 116. 1893.
- Achlya flagellata* Coker, The Saprolegniaceae, p. 116. 1923.
- Achlya rodrigueziana* F. T. Wolf, Mycol., 23: 274. 1941.
- Achlya caroliniana* Coker, Bot. Gaz. 50: 381. 1910.
- Achlya recurva* Cornu, Ann. Act. Nat. Bot. Ser. V, 15: 22. 1872.
- Achlya imperfecta* Coker, The Saprolegniaceae, p. 118. 1923.
- Aphanomyces laevis* deBary, Jahrb. wiss. Bot., 2: 179. 1860.
- Aphanomyces stellatus* deBary, Jahrb. wiss. Bot. 2: 178. 1860.
- Aphanodictyon papillatum* Huneycutt, J. Elisha Mitchell Sci. Soc., 64: 279. 1948.
- Brevilegnia diclina* Harvey, J. Elisha Mitchell Sci. Soc., 42: 243. 1927.
- Brevilegnia linearis* Coker and Braxton, J. Elisha Mitchell Sci. Soc., 42: 214. 1927.
- Dictyuchus monosporus* Leitgeb, Jahrb. wiss. Bot., 7: 357. 1869.
- Dictyuchus missouriensis* Couch, J. Elisha Mitchell Sci., Soc., 46: 227. 1931.
- Dictyuchus sterile* Coker, The Saprolegniaceae, p. 151. 1923.
- Geolegnia inflata* Coker and Harvey, J. Elisha Mitchell Sci. Soc., 41: 154. 1925.
- Isoachlya unispora* Coker and Couch, The Saprolegniaceae, p. 87. 1923.
- Isoachlya intermedia* (Coker and Harvey) Coker, North American Flora, 2: 27. 1937.
- Isoachlya toruloides* Kauffman and Coker, Amer. J. Bot. 8: 231. 1921.
- Isoachlya* spp. A number of isolates were obtained which failed to form oogonia even after several months in culture and hence were not identifiable.
- Leptolegnia subterranea* Coker and Harvey, J. Elisha Mitchell Sci. Soc. 41: 158. 1925.
- Leptolegniella keratinophilum* Huneycutt, J. Elisha Mitchell Sci. Soc., 68: 110. 1952.
- Plectospira* sp. A single isolate was observed which failed to produce sex

organs. Asexual characteristics resembled those of *P. gemmifera* Drechsler.

Saprolegnia ferax (Gruith) Thuret, Ann. Sci. Nat. Bot., 14: 214. 1850.

Saprolegnia mixta deBary, Bot. Zeit., 41: 38, 54. 1883.

Saprolegnia monoica Pringsheim, Jahrb. wiss. Bot., 1: 292. 1858.

Saprolegnia delicata Coker, The Saprolegniaceae, p. 30. 1923

Saprolegnia diclina Humphrey. Trans. Amer. Phil. Soc., 17: 109. 1893.

Thraustotheca clavata (deBary) Humphrey, Trans. Amer. Phil. Soc., 17: 131. 1893.

Leptomitales

Apodachlya brachynema (Hild.) Pringsheim, Ber. Deuts. Bot. Ges., 1: 289. 1883.

Apodachlya minima Coker and Leitner, J. Elisha Mitchell Sci., Soc., 54: 313. 1938.

Lagenidiales

Olpidiopsis aphanomycis Cornu, Ann. Sci. Nat. 15: 148. 1872
Parasitic in *Aphanomyces laevis* deBary.

Olpidiopsis pythii (Butler) Karling, The Simple Holocarpic Biflagellate
Phycomycetes, p. 47. 1942. Parasitic in the hyphae of *Pythium vexans*.

Olpidiopsis saprolegniae var. *levis* Coker, The Saprolegniaceae, p. 185.
1923. Parasitic in *Saprolegnia* sp.

Olpidiopsis achlyae McLarty, Bull. Torrey Bot. Club, 68: 62. 1941.
Parasitic in the hyphae of *Achlya flagellata*.

Lagenidium destruens Sparrow, J. Wash. Acad. Sci., 40: 54. 1950.
Parasitic in the hyphae of *Achlya recurva* Cornu.

Peronosporales

Pythiogeton transversum Minden, In, Falck, Mykol. Untersuch. Ber., 2: 242. 1916.

Pythium carolinianum Matthews, Studies on the Genus *Pythium*, p. 71.
1931.

Pythium aphanidermatum (Edson) Fitzpatrick, J. Agr. Res., 4: 279. 1915.

- Pythium afertile* Kanouse and Humphrey, Papers Mich. Acad., 8: 127. 1927.
- Pythium irregulare* Buisman, Med. Phytopath. Lab., 11: 1-15. 1927.
- Pythium monospermum* Pringsheim, Jahrb. wiss. Bot., 1: 284. 1858.
- Pythium nagaii* Ito and Tokumago, J. Fac. Agr. Hokkaido Imper. Univ., 32: 201. 1933.
- Pythium papillatum* Matthews, J. Elisha Mitchell Sci. Soc., 43: 229. 1928.
- Pythium pulchrum* Minden, In, Falck, Mykol. Undersuch. Ber., 1: 146. 1916.
- Pythium rostratum* Butler, Mem. Dept. Agr. India Bot., 1: 1. 1907.
- Pythium vexans* deBary, J. Bot., 14: 105. 1876.
- Pythium debaryanum* Hesse, Inaugr. Disert. Halle. 1894.
- Pythium graminicolum* Subramaniam, Agr. Res. Inst. Pusa Bull. 177. 1-5. 1928.
- Pythium gracile* Schenk, Verhandl. Phys. — Med. Ges. Wurzburg 9: 12. 1859.
- Pythium proliferum* deBary, Jahrb. wiss. Bot., 2: 169. 1860.
- Pythium ultimum* Trow, Ann. Bot., 15: 269. 1901.

References Cited

- Coker, W. C. and V. D. Matthews, 1937. North American Flora, 2: 1-76.
- Gilman, J. C. 1957. A Manual of Soil Fungi. The Iowa State College Press, Ames, Iowa.
- Johnson, T. W. 1956. The Genus *Achlya*. The University of Michigan Press, Ann Arbor, Michigan.
- Raper, J. R. 1937. A Method of Freeing Fungi from Bacterial Contamination. Science, 85: 342.
- Sparrow, F. K. 1943. Aquatic Phycomycetes. The University of Michigan Press, Ann Arbor, Michigan.

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News and Notes

(Editor's Note — News contributions should be sent to the person whose name appears at the end of the appropriate sections.)

AGRICULTURE SECTION

Mr. C. I. Rich, Professor of Agronomy at Virginia Polytechnic Institute, was elected Chairman of the Soil Chemistry section of the Soil Science Society of America.

Recent staff appointments to the Agronomy staff at V.P.I. were Mr. J. Sundstrom as Instructor and Mr. W. J. Meyer as Assistant Professor. Mr. Sundstrom is a graduate of the University of Missouri while Mr. Meyer received his degrees at Ohio State and Perdue.

Commissioner Parke C. Brinkley and Dr. W. L. Bendix, State Veterinarian and Director of the Division of Animal and Dairy, Virginia Department of Agriculture, received a Certificate of Appreciation from the United States Department of Agriculture for its fast action in eradicating Vesicular Exanthema from swine in the state.

Mr. Rodney C. Berry, State Chemist and Director of the Division of Chemistry and Foods of the Virginia Department of Agriculture received the 1960 Distinguished Service Award from the Virginia Section of the American Chemical Society.

Mr. William R. Maynard, Jr., of the Virginia Department of Agriculture's Drug Laboratory has been named to the 60-man Board of Revision of the United States Pharmacopoeia. Mr. Maynard, who will serve a 10-year term, was selected from more than 1,000 nominees.

Paul B. Siegel

ASTRONOMY, MATHEMATICS PHYSICS SECTION

Hollins College is planning for a new science building. Construction will begin in the near future.

The University of Virginia is offering a Summer Research Participation Program under the auspices of N.S.F. Fellowships are available to both high and college teachers of Physics. It is hoped that the program may be offered in future years. Information may be obtained by writing

Prof. J. W. Beams.

The new science building at Lynchburg College has been recently dedicated. It houses the departments of Physics, Biology, Chemistry and Mathematics.

Mr. James Jacobs has been appointed chairman of the Department of Physics at V.P.I. He comes from the University of Iowa where he was Professor of Physics and Director of Nuclear Research. Mr. Keith Furr will join the Physics Faculty in September. He recently completed his graduate work at Duke University.

Mr. Wilbur Payne has resigned from the Physics staff at V.P.I. in order to join the staff of O.R.O.

The master's degree program at William and Mary is growing rapidly. It is being offered to selected personnel of NASA. The staff will be increased by the addition of two new assistant professors, Mr. J. D. Lawrence recently at U. Va., and Mr. McClay from the University of Missouri.

Prof. I. G. Foster of the Physics Dept. of V.M.I. has recently resigned. He will become chairman of the Division of Mathematics and Science at Florida Presbyterian College at St. Petersburg.

Mr. Robert Yates of William & Mary's Department of Mathematics has resigned to join the staff of the University of South Florida at Tampa.

I. G. Foster

BACTERIOLOGY SECTION

The Virginia Branch of the Society of American Bacteriologists met October 3, 1959 at the Medical College of Virginia, Richmond, in conjunction with the Laboratory Section of the Virginia Public Health Association. Part of the program was a symposium: "Staphylococci Phage Typing." The elected officers for the calendar year 1960 were, President, Quentin Myrvik; Vice President, Catherine M. Russell; Secretary-Treasurer, Wesley A. Volk; Section Editor P. Arne Hansen; Councilor, Herbert Welshimer.

P. Arne Hansen

BIOLOGY SECTION

The Departments of Science (Biology, Chemistry and Physics) of

Emory and Henry College have received an NSF grant to defray expenses of a summer institute for high school graduates. It is expected that 50 students will participate in the five weeks course covering Physical Science, Chemistry and Radiation Biology. The courses will be taught by W. T. Graybeal, T. H. Ma, W. Stamper and Professor Young.

Mr. Fred S. Orcutt has been named head of the Virginia Polytechnic Institute Biology Department, effective January 1, 1960.

Mr. W. W. Scott, Virginia Polytechnic Institute, was on leave of absence January 15 to June 15. He accepted a visiting professorship at the University of Wisconsin, in botany, for the second semester, 1959-60.

Mr. Perry C. Holt of the Biology Department, Virginia Polytechnic Institute, has been awarded a grant of \$14,500 by the National Science Foundation to enable him to continue his studies of the systematics of the oligochaete family Branchiobdellidae. The grant is for a period of three years and will make possible collecting trips to the western United States and Mexico.

Professor Ruskin S. Freer of Lynchburg College was the recipient of an honorary Doctor of Science degree from Culver-Stockton College, February 3, 1960.

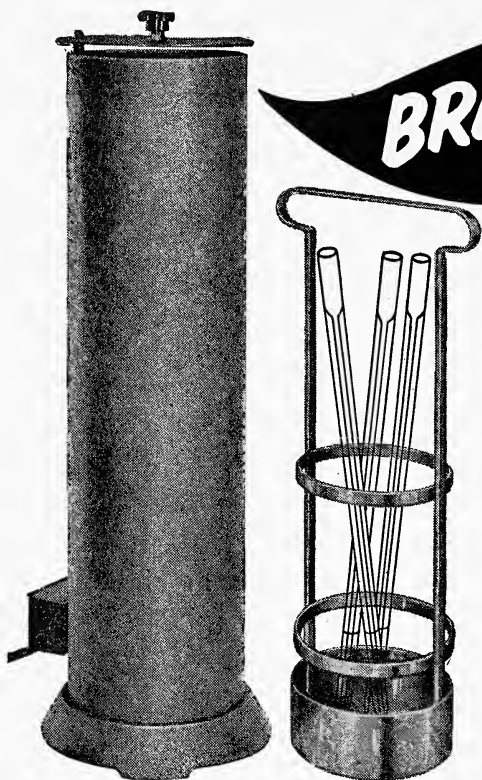
Mr. Jack D. Burke of the University of Richmond was a National Science Foundation Lecturer at the Summer Institute of Columbia College, Columbia, South Carolina in August, 1959. His three weeks course was entitled "Recent Advances in the Principles of Zoology." The National Institute of Health has awarded Mr. Burke a grant of \$15,755 for a three-year study of "Fish-blood oxy-hemoglobin affinity." This study will be done in Virginia fresh waters.

Mr. James N. Dent, on leave from the University of Virginia, is conducting research at the Gatty Marine Laboratory, St. Andrews University, Scotland, under a Guggenheim Fellowship.

Mr. Billy E. Frye, Visiting Assistant Professor in the Department of Biology, University of Virginia, has been awarded a grant for \$16,687 by the National Science Foundation for continuing his studies on the functional development of the pancreas.

Mr. I. D. Wilson, formerly Head, Department of Biology, Virginia Polytechnic Institute, and now serving with the United States Technical Cooperation Mission, Izatnagar, U. P., India, wrote that he and Mrs. Wilson plan to return to the United States this year. They are scheduled to sail from Bombay on April 13, spend two months in Europe, reaching home in Blacksburg, Virginia, in the later part of June. Mr. and Mrs.

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Wilson participated in a tiger hunt during the holiday season at the camp of a friend. Mr. Wilson was stationed at a machan, where he sat with his camera accompanied by another guest with a rifle. Their host was perched in a nearby tree. Mrs. Wilson rode an elephant in the line of beaters. At one point her elephant almost bolted, so she dismounted while the beast was quieted. In so doing she almost stepped on the tiger's tail as it lay hidden in the deep jungle. Finally she remounted and drove in, not one but two tigers. In the excitement Mr. Wilson forgot to snap his camera, and the guest failed to shoot. Their host, however, came to the rescue and shot one of the tigers. The other bounded away into the jungle and escaped.

W. S. Flory Jr., University of Virginia, has received a National Science Foundation grant of \$22,000 for the support of a biosystematic analysis of *Zephyranthes* and of *Hymenocallis*.

W. S. Flory Jr.

ENGINEERING SECTION

It is with deep regret that the passing on January 5 of Professor Frank Vilbrandt is recorded. Professor Vilbrandt, long head of the chemical engineering department at Virginia Polytechnic Institute, where he has taught since 1935, was responsible for building this department to its present important position in its field.

Professor Fred Bull, head of the Virginia Polytechnic Institute chemical engineering department, has announced that his group has moved in its new building where it occupies 50,000 square feet in offices, classrooms, ten large research laboratories and a well equipped unit operations laboratory towering fifty feet through four floors. Professor Stuart B. Row of this chemical engineering department has been appointed Assistant Director of the Virginia Engineering Experiment Station. Professor Nelson F. Murphy is co-author of a paper "Properties of the Water-Benzene-Triethylene Glycol Dimethyl Ether System" in *Chemical and Engineering Data* for April 1960.

Mr. Tilton E. Shelburne of the Virginia Council for Highway Investigation and Research has continued as a member of the Advisory Committee of the AASHO Road Test and attended a meeting of this committee in LaSalle, Illinois in May. Mr. Shelburne and Professor William Zuk of the civil engineering department at the University of Virginia attended a conference on Road Loading Mechanics held by the National Academy of Science in Washington in April. Professor Zuk has published a paper in the *Journal of Aeronautical Sciences* on "A Method

of Transforming Concentrated Surface Forces into Continuous Surface Forces.”

Dean Lawrence R. Quarles of the Engineering School, University of Virginia, and Professor Orville Harris of the electrical engineering department attended the First International Meeting of the Institute of Radio Engineers in March. Dean Quarles also attended the national meeting of the AIEE in New York in February. He has been elected Chairman of the Virginia Section of the AIEE. Professor Robert L. Ramey of the electrical engineering department has published a paper in the *Proceedings of the American Vacuum Society* on the subject “Design and Theory of Sub-Miniature Ionization Gauge Tubes.”

R. M. Hubbard

VIRGINIA ACADEMY OF SCIENCE

MINUTES OF COUNCIL MEETING — MARCH 12, 1960

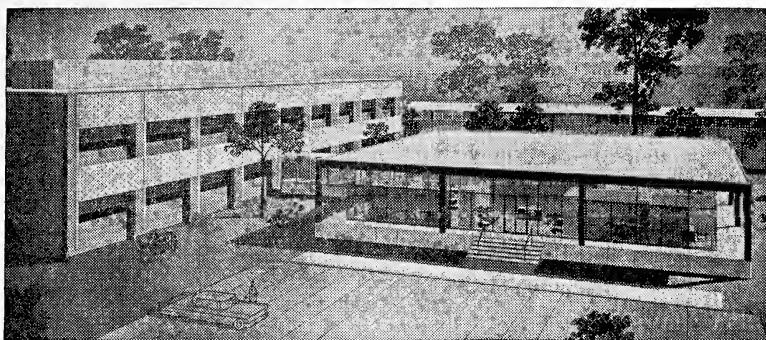
The meeting was held at the University Center, Richmond, Virginia. Dr. Hinton called the meeting to order at 10:35 a.m. Others present were:

Dr. Wilson Bell
Dr. Horton Hobbs
Dr. Thomas Gilmer
Dr. J. C. Forbes
Mr. Jackson Taylor
Mr. E. S. Harlow
Mr. Foley Smith
Dr. Boyd Harshbarger

Col. H. W. K. Fitzroy
Mr. William Gresham
Dr. Lynn Abbott
Dr. Jack Burke
Dr. Fontaine Armistead
Dr. E. C. Cogbill
Dr. Lewis Goldstein
Mr. William Wartman, Jr.

Local Arrangements Committee Report:

At Dr. Hinton's invitation, members of the Local Arrangements Committee attended the meeting. Mr. Gresham, Chairman, distributed copies of the General Program for the May meeting and members of the committee reported briefly on their activities. It was suggested that certain materials which are used each year, such as signs, be stored and made available to succeeding committees. Dr. Armistead suggested that a permanent chairman for local arrangements be considered. Mr. Gresham was asked to make a list of suggestions which would be useful to future local arrangement committees.



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into packaging and adhesive materials.

We are looking forward to the achievements to come from this new laboratory complex. We sincerely believe our greater emphasis on fundamental research will be an important factor in the continued growth of both our company and the industries we serve.

PHILIP MORRIS INC.

Dr. Abbott reported that a hotel information listing had been forwarded to the secretary. The secretary had this and other information on the meeting ready for mailing to the membership.

The necessity of a large number of meeting rooms for technical sessions and extensive space for Junior Academy exhibits and commercial exhibits for the annual meeting was discussed. This was in regard to planning for future meetings.

Since the minutes of the last meeting are published in the Journal, a motion was passed that they not be read at this meeting. The president announced the appointment of a committee consisting of Doctors Bell, Harshbarger, Ross, and Kral to study the operation of the Virginia Journal of Science and to report at the May meeting of the council.

Treasurer's Report and 1960 Budget:

The treasurer gave a brief report; the balance in the General Fund on March 1, 1960 was \$2,138.03.

Dr. Harshbarger presented the report of the Finance and Endowment Committee, which included the proposed budget for 1960.

A motion was passed that the treasurer's report and the budget for 1960, as recommended by the Finance and Endowment Committee, be approved.

Business Membership Committee Report:

Mr. Harlow, Chairman of the Business Membership Committee, presented a report in which it was recommended that the names of the business members be presented in an appropriate place of distinction in all issues of the Journal. A motion was passed that this be done.

The report also outlined a program for soliciting new business members. A letter to prospective members from the committee chairman will be followed up by personal contacts from committee members. Business membership certificates will be given to business members.

In the report it was also recommended that business firms desiring memberships, other than business, be asked to designate an individual for such a membership, since such memberships are only for individual members.

The council accepted the report of this committee, concurring in its recommendations.

In soliciting new individual memberships, Dr. Hinton described a plan for an academy member on the faculty of colleges and universities to contact new faculty members. Dr. Hinton will also write letters to

these new faculty members inviting them to become academy members.

Report of Visiting Scientists Committee:

Colonel Fitzroy reported that the visiting scientists program initiated last fall was well received as evidenced by letters from both the participating institutions and the visiting scientists. All but three four-year colleges in the states participated.

An application has been submitted to the National Science Foundation for funds to support a similar program for the 1960-61 academic year.

Dr. Forbes suggested that council give some thought to a similar program at the secondary school level, with the Academy and the University Center, jointly, submitting an application to the N.S.F. for funds to support such a program. He further suggested that the section chairmen be requested to express their thoughts on this matter.

Report of Research Committee:

Mr. Taylor reported that three grants had been awarded this year and several more are pending. The committee will meet on May 7 to select the recipient of the Horsley Award.

One of the members suggested that the academy might do more in publicizing the availability of research grants. He pointed out that small grants are not easily available from other sources. Mr. Taylor cited the failure of many applicants to file proper applications.

A committee, composed of Dr. Horton Hobbs, Dr. Wilson Bell and Dr. Boyd Harshbarger was appointed to select the two recipients of the Goethe Award for this year.

Mr. Taylor suggested that in the future a standardized procedure be adopted for selecting the recipients of the Goethe Award, and that requirements and the procedure for submitting applications be publicized.

Announcements:

Dr. Robert Yates will leave the state at the end of this college year. His resignation was accepted with regret and at the May meeting a council member will be elected fill his unexpired term.

In accordance with the authorization voted at the Business Meeting of the Education Section in May, 1959, this section has been disbanded. Council was notified of this action by Mr. G. W. Kent, Acting Chairman.

The usual meeting of section chairmen will not be held at the May meeting. Dr. Hinton will invite the section chairmen to attend the council

meeting on Thursday, May 12.

The meeting was adjourned at 1:25 p.m.

William Wartman, Jr.

Assistant Secretary-Treasurer

THE ANNUAL SUBSCRIPTION RATE is \$3.00, and the cost of a single number, \$1.00. Reprints are available only if ordered when galley proof is returned. All orders except those involving exchanges should be addressed to Robert Kral, Virginia Polytechnic Institute, Blacksburg, Virginia. The University of Virginia Library has exclusive exchange arrangements, and communications relative to exchange should be addressed to The Librarian, Alderman Library, University of Virginia, Charlottesville, Virginia.

NOTICE TO CONTRIBUTORS

Contributions to the Journal should be addressed to Robert D. Ross, Virginia Polytechnic Institute, Blacksburg, Virginia. If any preliminary notes have been published on the subject which is submitted to the editors, a statement to that effect must accompany the manuscript.

Manuscripts must be submitted in triplicate, typewritten in double spacing on standard 8½" x 11" paper, with at least a one inch margin on all sides. Manuscripts are limited to seven pages, with the proviso that if additional pages are desired, the author may obtain them at cost. The author may estimate the length of his paper by counting the total number of characters, including blank spaces, and dividing this by 3300. The result is the approximate number of printed pages in the Journal.

Division of the manuscripts into subheadings must follow a consistent plan, and be held to a minimum. It is desirable that a brief summary be included in all manuscripts.

Footnotes should be included in the body of the manuscript immediately following the reference, and set off by a dashed-line above and below the footnote content. Footnotes should be numbered consecutively from the beginning to the end of the manuscript.

Bibliographies (Literature Cited, References, etc.) should be arranged alphabetically according to author. Each reference should include the date, full title of the article, the name of the Journal, the volume, number (optional), pages, tables and figures (if any). For example: "Sniffen, Ernest W. 1940. Cobbles from the Pleistocene Terraces of the Lower York-James Peninsula Va. Journ. Sci., 1 (8): 235-288 1 fig., 1 tab. Reference to the bibliographic citations should not be made by numbers. Instead, using the above citations, where a reference is desired: either "Sniffen (1940)", (Sniffen, 1940: 186)", or "Sniffen (1940) states that . . ."

Explanation of figures, graphs, etc., should be typed on separate pages. All figures should be numbered consecutively beginning with the first text figure and continuing through the plates. If figures are to be inserted in the text this should be clearly indicated by writing "Figure —" at the appropriate place in the margin.

Illustrations including lettering, should be arranged so that on reduction they will not exceed the dimensions of the maximum size of a printed page. 4-1/2" x 6-1/2", and so that they are well balanced on the page. Large plates must be accompanied by 8-1/2" x 11" photographic copies which can be sent to the reviewers. The Journal will furnish the author with one plate (halftone or line reproduction) or its equivalent; additional figures, colored illustrations or lithographs may be used only if the author makes a grant covering the cost of production. Original drawings (which must be done in black drawing ink) not photographs of drawings, should accompany the manuscript. Photographs should not be used if a line and dot (stippled) drawing will suffice. If photographic prints are to be used they should be glossy, sharp and show good contrast. Drawings not neatly executed and labeled (do not use a typewriter), or which are submitted on yellow or yellowish-white paper will not be accepted.

Galley Proofs and engraver's proofs of figures are sent to the author for correction. Costs of excessive changes from the original manuscript must be defrayed by the author.

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THE VIRGINIA JOURNAL OF SCIENCE

A JOURNAL ISSUED QUARTERLY BY THE
VIRGINIA ACADEMY OF SCIENCE

PROCEEDINGS FOR THE YEAR

1959-1960



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September, 1960

No. 4



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No. 4

SEPTEMBER, 1960

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CONTENTS

	Pages
Officers of the Academy	142
Minutes of the Council, the Assembly and Conference of the Academy	150
Registration	154
Business Members	155
Financial Reports	155
Minutes of the Sections	157

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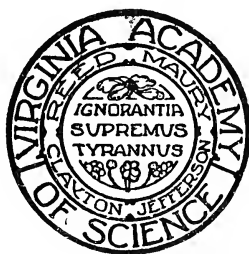
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VIRGINIA ACADEMY OF SCIENCE



Proceedings for the Year
1959 — 1960

MINUTES OF THE THIRTY-SEVENTH ANNUAL MEETING

MAY 6, 7, 8, 9, 1959

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1963

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THE VIRGINIA ACADEMY OF SCIENCE ASSEMBLY

BALL ROOM, JEFFERSON HOTEL, 8:00 P.M. MAY 13, 1960

The meeting was opened by President Hinton who introduced Colonel Herbert W. K. Fitzroy who welcomed the Academy on behalf of the University Center in Virginia. Colonel Fitzroy read the names of the Local Committee on Arrangements and complimented them on their work.

President Hinton then introduced Dr. Raymond L. Taylor, Associate Administrative Secretary of the AAAS who brought greetings from the Association.

President Hinton, acting for Mrs. Heatwole, announced the summer Teacher Sponsor Scholarships, one at the University of Virginia and the other at the College of William and Mary as:

Miss Virginia Ellett, Thomas Jefferson High School, and Mr. J. M. Lane, Victoria High School. Mr. J. P. Hill, Jr., of Stewartsville High School was named alternate to the former and Mrs. Martha Walsh, McLean High School, to the latter.

Dr. R. W. Engel announced the J. Shelton Horsley 31st Research Award selected from eleven competing papers was that of Mr. Lawrence I. Miller's entitled, "The Influence of Soil Components on the Survival and Development of the Sting Nematode." The Claude P. Talley, Lloyd E. Line, Jr., and Quinton D. Overman, Jr., paper entitled "Preparations and Properties of Massive Amorphous Elemental Boron" received Honorable Mention.

President Hinton announced that a set of bound volumes of the *Virginia Journal of Science* is to be presented to Dr. Mary E. Humphries in appreciation of her outstanding work on that Journal. Since she had not come to these meetings Dr. Horton Hobbs was asked to make the presentation later.

Miss Zoe Black read the resolutions formulated by the Resolution Committee which were approved.

Mr. Edward Harlow, Chairman of the Nominating Committee, presented the following slate:

President, Dr. Wilson Bell; President Elect, Dr. Horton H. Hobbs, Jr.; Secretary, Dr. Paul M. Patterson; Treasurer, Mr. Foley F. Smith; Assistant Secretary-Treasurer, Mr. William B. Wartman, Jr.; Council Member,

Miss Susie V. Floyd (5 years), Dr. Stanley B. Williams (4 years), Colonel H. W. K. Fitzroy (2 years).

Dr. Harshbarger moved that the Secretary be instructed to cast an affirmative ballot. The motion was seconded and passed.

President Hinton announced an invitation to the Academy to meet in Norfolk in 1962 had been received from The Norfolk Division of the College of William and Mary, together with the New Monticello Hotel, the Norfolk Chamber of Commerce and the Norfolk City Officials. He announced that this would be presented before Council in its morning meeting the next day.

Dr. Frank W. Finger then presented the speaker of the evening, Dr. Harry Harlow who spoke on the subject, "A Theory of the Development of Affection in Primates." After this interesting and informative illustrated lecture, Dr. Hinton thanked the Council officers, Committees and membership for their cooperation and turned the meeting over to President Bell who, after a few appropriate remarks, adjourned the Assembly.

COUNCIL MEETING

GLASGOW HOUSE, RICHMOND, VIRGINIA

10 A.M. MAY 14, 1960

President Bell called the meeting to order and welcomed the new members. Present were: W. S. Flory, J. C. Forbs, Susie V. Floyd, T. E. Gilmer, W. G. Guy, W. M. Hinton, H. H. Hobbs, G. W. Jeffers, P. M. Patterson, R. D. Ross, F. F. Smith, J. J. Taylor, W. B. Wartman, Jr., and S. B. Williams.

The minutes of the immediate past three meetings were reviewed to pick up unfinished business, then the agenda was completed for the meeting.

Dr. Guy presented the invitation for the Academy to meet in Norfolk in 1962. Dr. Gilmer moved the acceptance and it was seconded and passed.

Dr. Hinton moved that the registration fee for the Academy meetings be raised to \$1.00 for senior members and visitors, leaving it at fifty cents for students. This motion was seconded and passed.

Dr. Jeffers moved that signs be placed at Section meetings stating "Admission by Badge Only." This motion was seconded and passed. This was the outcome of a concern Council had over a number of per-

sons attending Section meetings without registering.

With regard to the Academy meeting place for 1963, Dr. Taylor moved that Council instruct President-elect, H. H. Hobbs to proceed on a meeting place for 1963 with the preference of the Hotel Roanoke for location.

A questionnaire from the AAAS Conference was then discussed. The four questions were answered as follows and the Secretary instructed to reply.

1. Should a strong National Junior Academy of Science be formed? No.
2. Should the local Junior Academy of Science remain under the sponsorship and jurisdiction of the local Senior Academy of Science? Yes.
3. If a strong national Junior Academy of Science is formed, should it be under the sponsorship or jurisdiction of the AAAS Academy Conference? No, under AAAS.
4. Would a new National Junior Academy of Science interfere with or harm any now existing National Youth Science group. Yes.

The proposals concerning the *Journal* as presented by Dr. Ross (reported on May 12 meeting) were discussed. Concerning advertisements Council advised that they be of a character appropriate to a scientific Journal. Dr. Ross advised that no fixed advertising price could be made as an advertising agency sold a package deal and defined the rate themselves. The increase of Academy support by \$400 was approved by Council subject to the favorable action by the Finance Committee. A storage place for back numbers of the *Journal* was discussed but no solution found.

Dr. Jackson Taylor moved that a gavel be purchased and that the Awards Committee make a suitable presentation at the 1961 meeting.

Dr. Hobbs pointed out that the Biology Section formed a Committee to back up movements to preserve unspoiled natural areas in eastern Virginia. Council voiced the opinion that such matters should go through existing channels of the Academy or come before Council, and that Sections should not act unilaterally in the name of the Academy.

Adjournment.

P. M. Patterson, Secretary

COUNCIL MEETING OF MAY 12, 1960

President Hinton called the meeting to order at 2 p.m. in the Glasgow House, Richmond. Present were: W. B. Bell, L. A. DeArmon, J. C. Forbes, T. E. Gilmer, W. G. Guy, Boyd Harshbarger, Thelma C. Heatwole, G. W. Jeffers, S. S. Negus, B. A. Niemeier, P. M. Patterson, E. W. Pullen, R. D. Ross, M. B. Rowe, W. W. Scott, O. R. Singleton, Jr., F. F. Smith, J. J. Taylor, J. C. Thompson, Jr., W. B. Wartman, Jr.

The minutes of the March 12th Richmond meeting of Council were read and approved.

Dr. Forbes reported that NSF funds for 1959-60 Visiting Lecturers were not used entirely and over \$1300 was returned. He reported that NSF funds were again available for visiting lecturers to the amount of \$4890 and pointed out that NSF desired we enlarge the program by inviting high school science teachers and students to the general lecture given by the visiting scientists. With the reduced honorarium (\$20 per diem) Dr. Forbes suggested the utilization of scientists in the state or geographically close by for this year's program. Dr. Jackson Taylor moved that the Visiting Scientists Program as outlined by Dr. Forbes be endorsed by Council. It was seconded and passed.

Mrs. Heatwole recommended that the chairman of the Junior Academy of Science Committee be made a member of Council.

Dr. Thompson recommended a reorganization of Council as follows: 1) that Council be composed of members elected by the several Sections, each Section designating one of their members as representing their Section on Council. 2) that the Nominating Committee for the officers of the Academy be the Council itself.

Mr. Harlow moved that the proposals made by Mrs. Heatwole and Dr. Thompson be studied by a Committee to be appointed by incoming President Bell. It was seconded and passed.

The Goethe Awards for travel expenses to the meeting were announced by Drs. Harshbarger and Hobbs as going to Charles Quesenbery of VPI and Harison R. Steeves of the University of Virginia.

Dr. Ross reported on the *Virginia Journal of Science* giving a financial statement and proposed budget for 1960-61. He then outlined in detail the duties of the Editor and Manager and designated plans for the improvement of the *Journal* as follows: 1. The *Journal* should appear promptly each quarter; 2. Its articles should be more representative of the several sciences; 3. That the report of the Committee headed by Dr.

Bell to study the finances of the *Journal* be considered, and follows in part:

1. Increase pages of advertising from 6 to 12. 2. Increase in advertisement rates. 3. An additional subsidy from the Academy of \$400. 4. That an Advertising Manager be appointed and that the services of an advertising agency be acquired. Dr. Hobbs moved that Council receive this report with thanks to the Committee for their work. This motion was seconded and passed.

President Hinton reported he had represented the Academy at the recent Presidential inaugurations at the University of Virginia and Washington and Lee University.

Mr. Wartman presented a proposed form to be printed for the Academy's Certificate of Business Memberships and asked for suggestions as to its format.

Mr. Smith reported he had taken out liability insurance to cover the three days' meeting of the Academy.

MEETING OF THE ACADEMY CONFERENCE

HOTEL JEFFERSON, MAY 12, 1960 — 8:00 P.M.

President Hinton presided and called for the reports of Committees published elsewhere in this issue. With respect to obtaining the \$400 additional subsidy requested for the *Journal* (see previous minutes) Dr. Forbes recommended that the registration fee of fifty cents be raised to \$1.00. It was moved that Council consider this matter and the group would favor Council's decision. This motion was seconded and passed.

TABULATION OF REGISTRATION

The Junior Academy of Science registered 207 members. The registration according to Sections was: Agricultural Sciences, 21 members, 24 nonmembers, total 45; Astronomy, Mathematics and Physics 46 members, 31 nonmembers, total 77; Bacteriology 14 members, 8 nonmembers, total 22; Biological Sciences 60 members, 31 nonmembers, total 91; Chemistry 85 members, 46 nonmembers, total 131; Engineering 10 members, 13 nonmembers, total 23; Geology 13 members, 5 nonmembers, total 18; Medical Sciences 16 members, 8 nonmembers, total 24; Psychology 32 members, 20 nonmembers, total 52; Science Teachers 14 members, 8 nonmembers, total 22; Statistics 13 members, 16 nonmembers, total 29. Three members and 37 nonmembers registered without preference to section. The total registration was 781.

VIRGINIA ACADEMY OF SCIENCE BUSINESS MEMBERS

At a recent Council Meeting it was decided to send Business Membership Certificates to all business members and that the Company names be listed in an appropriate place in the *Journal*. Currenly there are seventeen business members.

BUSINESS MEMBERS, AUGUST 12, 1960

Allied Chemical Corporation, Nitrogen Division, Development Department, Hopewell, Virginia. The American Tobacco Company, Department of Research and Development, 400 Jefferson Davis Highway, Richmond 24, Virginia. E. I. DuPont de Nemours & Co., Inc., Textile Fibers Department, Richmond, Virginia. The Dow Chemical Company, Textile Fibers Department, Attn: Mr. O. R. McIntire, Technical Director, Williamsburg, Virginia. Esso Standard Oil Company, Attn: Mr. C. C. Pembroke, Broad & Hamilton Streets, Richmond, Virginia. First and Merchants National Bank, Attn: Mr. R. T. Marsh, Jr., President, Richmond 17, Virginia. General Electric Company, Employee & Community Relations, Attn: Mr. Paul R. Thomson, Manager, 1501 Roanoke Boulevard, Salem, Virginia. Larus & Brother Company, Inc., Attn: Mr. A. T. Webster, Secretary and Treasurer, Richmond 17, Virginia. Merck and Company, Inc., Research Laboratories, Attn: Dr. Max Tishler, Rahway, New Jersey. Philip Morris & Co., Ltd. Inc., McComas Research Center, Attn: Dr. Helmut Wakeham, Director of Research, P. O. Box 3D, Richmond 6, Virginia. The Newport News Shipbuilding & Drydock Company, Newport News, Virginia. Norfolk and Western Railway Company, Attn: Mr. Martin P. Burks, Roanoke 17, Virginia. Phipps and Bird, Inc., 303 South 6th Street, Richmond, Virginia. A. H. Robins Company, Inc., 1407 Cummings Drive, Richmond, Virginia. Reynolds Metals Company, Attn: Mr. R. S. Reynolds, Jr., Richmond, Virginia. State-Planters Bank of Commerce and Trusts, Attn: Mr. Charles E. Moore, Jr., Vice President, Richmond 14, Virginia. Virginia-Carolina Chemical Corp., Research Department Library, Box 1136, Richmond 8, Virginia.

GENERAL FUND

STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS
FOR THE YEAR ENDED DECEMBER 31, 1959

BALANCE ON DEPOSIT—JANUARY 1, 1959 \$ 5,432.60

RECEIPTS:

Revenue:

Dues:

Regular members	\$ 2,130.00	\$ 4,294.00
Collegiate members	32.00	

Contributing members	663.00	
Sustaining members	380.00	
Business members	1,000.00	
Delinquent dues	89.00	\$ 4,294.00
Gifts, grants and bequests:		
Virginia Junior Academy		
of Science		750.00
General		200.00
Non-Revenue:		
Major W. Catesby Jones Award		
Fund		10.00
Advance Payment of Dues		18.00
Receipts from annual meeting,		
May, 1959:		
Collection of Advance due from Research Account	40.00	
Fees for exhibit space	\$ 700.00	
Registration fees	291.00	991.00
Miscellaneous collections		94.34
Sale of James River Basin books		10.50
Dividends on stock		119.15
Income from special trust fund (Exhibit G)		96.06
Award check (1955) cancelled		11.65
<i>Total Receipts for the Year</i>		6,634.70
<i>Total Funds Available</i>		\$12,067.30
DISBURSEMENTS:		
Annual Meeting Expense	\$ 988.36	
American Association for the Advancement of		
Science Meeting	359.52	
Virginia Junior Academy of Science	2,164.83	
Postage and express	89.32	
Printing	69.76	
Science talent search	449.14	
Stationery, supplies and stenographic services..	111.14	
Virginia Journal of Science	2,005.75	
Dr. E. C. L. Miller Award	50.00	
Major W. Catesby Jones Award	10.00	
Miscellaneous and General Expense (Schedule		
B-1)	371.59	
Cash transfer to Special Trust Fund Principal		
Account (Exhibit F)	3,000.00	
<i>Total Disbursements for the Year</i>		9,669.41
BALANCE ON DEPOSIT — DECEMBER 31, 1959		
(Exhibit A)		\$ 2,397.89

SECTION OF AGRICULTURE

PHOTOPERIODISM IN TURKEYS

A. T. Leighton, Jr.; *Virginia Polytechnic Institute*

1. This study was designed to obtain information on the photoperiodic response of female turkeys as measured by reproductive responses to various light regimes. Light, restricted to 6 hours per day for a 2 or 4 week period and subsequent exposure to 15 hours of light, made it possible to induce turkeys to lay at a significantly earlier age and at a higher rate during the fall than females which were previously maintained under 14 hours of natural daylight. Light alteration resulted in a change in time of response but had no apparent effect on total egg production over a 6 months production period. (Study conducted at the Minnesota Agricultural Experiment Station, St. Paul, Minnesota.)

SUSCEPTIBILITY OF THREE BREEDS OF CHICKENS TO BLACKHEAD

Everett E. Lund; *Animal Disease and Parasite Research Division,
A.R.S., U.S.D.A.*

2. New Hampshire Reds, White Leghorns, and first generation crosses of New Hampshire Red males and Bared Rock females, all 5 weeks of age, were given equal numbers of embryonated *Heterakis* eggs from a source known to transmit blackhead. *Histomonas* infection appeared in 92, 75 and 66 percent of these birds, respectively, and 25, 21 and 6 percent, respectively, remained carriers after the acute state subsided. Worm loss was in direct proportion to the severity of the blackhead. Infectivity of eggs from worms recovered from the above birds varied according to the incidence of blackhead. All breeds were capable of significant soil contamination.

A MODIFIED EXTRACTION-TITRATION

TEST FOR FREE FAT ACIDITY OF MILK AND CREAM

W. K. Stone and P. M. Large; *Virginia Polytechnic Institute*

3. Free fat acidity (FFA) was determined using equipment common to dairy quality control laboratories. Nine ml. of milk were shaken in a Babcock cream-test bottle for 1 minute with 10 ml. of neutralized 95% ethanol. This mixture was extracted by shaking for 1 minute with 15 ml. of 40/60 ethyl-petroleum ether and centrifuged for 3 minutes in a Babcock centrifuge. Five ml. were decanted, mixed with 5 ml. of neutralized ethanol; and titrated with ca. 0.01 N alcoholic KOH. $\text{FFA} = \text{net ml. KOH} \times \text{N} \times 300 \div \text{by weight of fat in the sample. To}$

test cream for FFA, an amount containing 0.40 g. of fat was weighed, diluted to 9 ml. with H_2O , and tested as above.

THE EFFECT OF DIETARY SODIUM BROMIDE LEVEL UPON THE RATS' GROWTH AND CARCASS AND LIVER BROMIDE LEVELS

Russell F. Miller and Janet M. Paulsen;
Virginia Polytechnic Institute

4. The addition of 0.25, 0.50, 0.75, or 1.00 g of NaBr/kg of purified diet for 6 weeks, did not adversely affect the growth of weanling albino rats. Based upon fresh weight, these rats' liver bromide levels increased (control 4 ppm) to 48 ppm (0.25 g NaBr/kg diet) then linearly to 79 ppm as the dietary NaBr level increased to 1.00 g/kg of diet. Carcass bromide levels, fresh basis, increased linearly from a control value of 15 ppm to 118 ppm when 0.75 g of NaBr/kg of diet was fed and did not increase further when feeding 1.00 g of NaBr/kg of diet.

THE BLOOD PICTURE IN WOOD SHEEP AND DAIRY GOATS

Lubow A. Margolena; *Sheep and Fur Animal Research Branch, A.R.S.,
U.S.D.A.*

5. The haematology of two groups each of Mernio and Hampshire sheep and Toggenburg goats was studied throughout the seasons of the year at Beltsville, Maryland. One group was on pasture, the other on a standard diet. Despite considerable individual differences, average values tend to be representative of a breed if considered on a long range basis. Hampshires averaged 13.7 gr. haemoglobin per 100 ml. blood, Merinos 13.2 and Toggenburg does 12.8 respectively. Yearly percent averages for red cell volume were 37.8 for Hampshires, 36.2 for Merinos, and 32.8 for the docs. Sedimentation rates read on 24 hour perpendicularly steadied Wintrobe tubes were fractions of 1 in all healthy animals. A rate of 2 and over was found only in a buck dying of pneumonia.

GENETIC PARAMETERS CONCERNED WITH FEED EFFICIENCY FULL FED BEEF CATTLE

James A. Gaines; *Virginia Polytechnic Institute*

6. Data on 276 bulls individually fed at the Beef Cattle Research Station, Front Royal, and on 152 steers individually fed at the Virginia Agricultural Experiment Station at Blacksburg were available for this study. The least squares method of analysis was used. In the first phase the data were adjusted for years, breeds, initial weight, and total

gain prior to estimating heritabilities of .79 in the bulls and .09 in the steers for TDN/cwt. gain. In the second phase individual total gains and TDN/cwt. values were adjusted for years, breeds, and initial weight prior to estimating genetic correlations of -1.31 in steers and -0.67 in bulls.

THE EFFECTS OF VARIOUS LEVELS OF LYSINE IN THE DIET ON MUSCLE DEVELOPMENT AND ON VARIOUS BLOOD PHENOMENA OF GROWING SWINE

G. M. Cahilly, R. F. Kelly, C. C. Brooks, J. W. Davis, and P. P. Graham;
Virginia Polytechnic Institute

7. An experiment was conducted involving 24 pigs to determine the effects produced by feed-protein quality on various physiological phenomena in growing swine. A corn-peanut oil meal ration supplemented with graded levels of lysine was used. Preliminary results indicated that lysine supplementation to this ration increased muscle mass, the nature of this increase being in the form of protein, not water or fat. Figures also indicated that changes may occur in organ weights and in blood patterns as a result of feed-protein quality. Determination of blood fractions, muscle lysine, as well as rat-growth study are in progress.

THE EFFECTIVENESS OF THREE MANAGEMENT SYSTEMS FOR THE CONTROL OF INTERNAL PARASITES OF LAMBS

James H. Turner, K. C. Kates, I. Lindahl, G. E. Whitmore, and
F. D. Enzie; *Agricultural Research Service, Beltsville, Md.*

8. From March to September of 1959, 3 bands of 20 lambs each were raised on dry lots, "clean" pastures, and parasite-contaminated pastures, respectively and were kept under parasite surveillance. Each band was thus exposed to low, moderate, and high levels of parasitism, respectively. All lambs were on phenothiazine-salt prophylaxis. The principal parasites observed in the pastured lambs were *Haemonchus contortus* and *Strongyloides papillosus*, which caused anemia and inhibited growth. In the dry-lot group, significant parasitism did not develop, and therapeutic medication was unnecessary. The lambs exposed to high levels of parasitism required additional medication in June, whereas those exposed to moderate parasitism did not require therapeutic medication until late summer.

PESTICIDE RESIDUES

James F. Eheart, P. H. Massey, Jr., E. C. Turner and Jean Dickinson;
Virginia Polytechnic Institute

9. Persistence curves, with recovery data, were made on 4 different

residues on collards, green beans, alfalfa and milk. Studies of the adaptation of the sodium biphenyl reduction method for organic chloride residues (endrin) with colorimetric determination of the resulting chloride ions by the ferric perchlorate-mercuric thiocyanate method was attempted.

CALCIUM SOURCES FOR PEANUTS

D. L. Hallock; *Virginia Agricultural Experiment Station*

10. Plenty of available calcium is required in the fruiting zone of peanuts. Four substances were evaluated as calcium sources for peanuts during the period 1956 to 1959. Rates of application were such to give 150 pounds per acre of calcium. The average acre value of the peanuts was \$0.56, 3.00 and 3.75 greater from gypsum (landplaster) than from North American Cement Company potash lime, burnt shell lime, and finely ground limestone, respectively. For the peanut farmers of Virginia this would mean a difference of from \$59,000 to as much as \$400,000, annually, exclusive of the differential in cost of the various materials.

THE INFLUENCE OF SOIL COMPONENTS ON THE SURVIVAL AND DEVELOPMENT OF THE STING NEMATODE, *Belonolaimus longicaudatus* RAU

Lawrence I. Miller; *Virginia Agricultural Experiment Station*

11. Experiments conducted in the laboratory and greenhouse showed that osmotic concentration, temperature, and the pH of a liquid medium; the number of roots in a soil; the addition of organic matter and of sulphur to a soil; and the moisture level and the texture of a soil affects survival and development of the sting nematode, *Belonolaimus longicaudatus* Rau. Results of experiments conducted in the field in Virginia for the last 10 years showed, however, that soil texture was the principal limiting factor. It is concluded that this sting nematode is limited to soils of a certain texture.

TWO RECENT DEVELOPMENTS OF GREAT SIGNIFICANCE IN CORN GROWING

W. W. Moschler; *Virginia Polytechnic Institute*

12. Corn growing in Virginia in the future will be influenced by 2 new practices, "minimum tillage" and "soil profile modification." "Minimum tillage" is the growing of corn with the least amount of soil tillage necessary. The amount necessary is less than that presently employed and can be concentrated on the corn rows at the time of planting, leaving the soil between the rows in a relatively rough state. "Soil profile modification" involves the mechanical incorporation of lime and fertilizer

to greater than normal depths in the soil, thus increasing the effective depth of the rooting zone. In limited trials in nearby states, this practice has increased resistance to drought.

DETECTION OF SEED TREATMENTS

W. F. Crosier* and C. F. Bruce; *Virginia Department of Agriculture*

13. Different fungi were studied and the following, listed in order of sensitivity, were found to be satisfactory for bio-assay: *Glomerella cin-glulata*, *Curvularia inaequalis*, *Aspergillus niger*, *Stemphylium consortiale*, and *Myrothecium verrucaria*. Pure cultures of these fungi are grown in tube slants (70°C or room temperature) on an agar medium (sabouraud dextrose agar). After the surfaces are covered with spores the tubes are stored at 5°C until needed. Ten ml. of sterile water is poured into tube slant and agitated. The suspension of spores is poured into 250 ml. of liquid agar (40 to 45°C). Before it solidifies the spore-laden agar is poured into sterile Petri dishes. The seeds to be assayed are placed on the spored agar immediately after it hardens. From 10 to 15 seeds of small grains or approximately 1/in.2 can be placed in a 90 mm. Petri dish. Dishes are held at room temperature, to permit germination of spores, for 2 to 3 days before measuring the inhibition zones or halos around the seed, produced by the presence of a fungicide. Distribution and intensity of treatment can be judged by size and consistency of the halos. This method clearly indicates the presence of a fungicide, but identification of the materials is not revealed by this assay. (*Seed Pathologist, New York State Agricultural Experiment Station, Geneva, New York.)

THE SOYBEAN CYST NEMATODE; A NEW VIRGINIA PEST

W. H. Matheny; *Virginia Department of Agriculture*

14. The Soybean Cyst Nematode, *Heterodera glycines* Ichinohe, known to occur in Japan since 1915, was discovered, for the first time in the United States, in North Carolina in 1954. A detection survey was inaugurated in 1955 by the Virginia Department of Agriculture Division of Plant Industry. In 1958, two farms in lower Nansemond County were found infested. A delimiting survey showed there were 3000 acres infested on 53 farms and as of May 1960 there were 125 infested farms. A Federal and State Quarantine was made effective on September 1, 1959. Compressed air machines were assigned to the 2 areas to clean farm machinery and crops were harvested and handled by approved methods to prevent spread. Crop rotations will control the pest and several chemicals although quite expensive will give control. Two soybean varieties, Illsoy and Peking, are reported to be resistant. The cur-

rent program objectives are to contain the pest, discourage the planting of host crops and keep trade channels open through certification.

AMMONIUM IN CERTAIN VIRGINIA SOILS

C. I. Rich; *Virginia Polytechnic Institute*

15. Significant quantities of ammonium occur naturally in certain Virginia soils and may be an important source of nitrogen for plants. As much as 800 pounds of N per acre as NH_4 may occur in the upper 5 feet of some virgin soils. This ammonium occurs as exchangeable ions or held in a "fixed" form by inorganic cation exchangers in soils. Vermiculite and weathered micas appear to be the major minerals retaining this ammonium. The proportion of the NH_4 which is fixed varies with the amount of vermiculite and its ability to contract when NH_4 or K saturated.

EFFECTIVENESS OF PHOSFON AS A CHEMICAL HEIGHT-RETARDANT ON POTTED CHRYSANTHEMUMS AND EASTER LILIES

Charles R. Downing and Staley L. Felton;
Virginia-Carolina Chemical Corporation

16. Phosfon, tributyl-2, 4-dichlorobenzylphosphonium chloride, retarded the height of chrysanthemums and Easter lilies when applied as a soil amendment. Rates of 0.25 to 0.5 gms. actual Phosfon per cu. ft. of potting soil reduced height about 50 percent. Treated plants were compact, had shorter internodes, stronger stems, leaves were very dark green, and blooms were not reduced in size or quality when treated at recommended rates. Flowering of treated plants was delayed slightly. All varieties of chrysanthemums responded, but some were more sensitive than others. Rates of application were adjusted to compensate for sensitivity. Phosfon effectively retarded the height of potted Easter lilies (Ace, Croft, and Georgia). Treated plants were compact, had shortened internodes, and the size and quality of blooms were not reduced. Phosfon appeared to be of commercial value to producers of potted chrysanthemums and Easter lilies.

THE IDENTIFICATION OF PAINT OILS VIA GAS-LIQUID CHROMATOGRAPHY

W. L. Zielinski, Jr., W. V. Moseley, Jr., and R. C. Bricker; Paint Laboratory; *Virginia Department of Agriculture*

17. Oil analysis by Gas-Liquid Chromatography offers a unique method for elucidating the changes undergone by oils in the varied manufacturing processes of the paint industry. Oils were extracted from paint vehicles and introduced into a Perkin-Elmer 154-C Vapor Fractometer

as fatty acid methyl esters. Correlation was made between fatty acid distributions obtained and known fatty acid distributions of vegetable and fish oils. Some effects noted in the manufacture of oil-containing resins included the disappearance of eleostearic acid of tung oil through polymerization; the increase in drying power of soybean oil as a result of linoleic acid conjugation; and the resolution of complex oil mixtures. Identification of unaltered oils is reported as routine.

WHAT CAN AN AGRICULTURAL ECONOMIST CONTRIBUTE TO RESEARCH IN THE NATURAL SCIENCES?

Ross V. Baumann, Farm Economics Research Division,
Agricultural Research Service, Washington, D. C.

18. Natural scientists and economists have been quite successful in cooperative research. However, only about 10 percent of the projects reported in the natural science research journals have reached the stage that would permit economic application directly to farming. Some experiments could be designed to meet this need, but in some cases additional experimentation would be necessary. The experiment must provide alternatives to select from, or show the production relationship over the relevant economic area. This enables the economist to compare returns from the alternatives with returns obtained from practices already a part of the farm business.

THE ROLE OF PRICE EXPECTATIONS IN AGRICULTURAL SUPPLY RELATIONSHIPS

Olman Hee; *Statistical and Historical Research, Agricultural Marketing
Service*

19. In economics we are frequently engaged in studies dealing with the law of supply. As the price of a product is increased, larger quantities of that product will be produced and offered for sale. The present study of supply-price relationships postulates that farm operators' actions are largely consistent with price movements, after allowing for technological, institutional and cultural changes. This essentially describes a supply function. The basic formulation in this statistical analysis expresses acreage of potatoes as a function of expected price and other factors. The formulation also assumes that farmers continually revise their price expectations in relation to prices they actually received in the past and those which they had expected to receive. Results from statistical analysis indicated an elasticity of supply with respect to expected price of about 0.5, while the elasticity with respect to price in the previous year was approximately 0.1.

PEANUT SUPPLY FUNCTIONS AND THEIR IMPLICATIONS FOR POLICY

D. Upon Livmore; *Virginia Polytechnic Institute*

20. The purpose of this study was to estimate the national production of peanuts from 1959 to 1965. Acreage allotments have been reduced to the minimum of 1,610,000 acres permitted by Congress. Yields per acre have been increasing. Production has exceeded national requirements in most years. Production estimates will be compared with expected requirements to determine the extent to which surpluses may be expected. Methodology includes use of state acreage, yield, and production models for the period 1909-1958; relationships among factors are analyzed by means of single linear equations determined by ordinary least squares. Projections of production are based primarily on projected yields and current levels of price support and acreage allotments.

USING TIME AND COST TECHNIQUES TO REDUCE COST IN VIRGINIA'S
EGG MARKETING FIRMSE. C. Garland, Jr.; *Virginia Department of Agriculture*

21. The introduction of automation in Virginia egg marketing firms presents new problems for management. The main problem appears to be: can the cost of automation be justified? Within the last three years, 22 time and cost surveys have been made to detect inefficiencies and excessive costs in Virginia egg marketing firms. These surveys revealed that it is not justifiable to candle poor quality eggs over automatic egg grading equipment. Usually hand candlerers are used to grade poor quality eggs, resulting in a higher candling cost because of management's inability to attain maximum labor efficiency in a dual candling process. A preliminary study was made to compare the cost of grading eggs on automatic machines, using reasonably well-trained personnel, and by the conventional hand grading method. The study indicated when the problems of labor and volume were solved, that eggs could be candled and packed one-half cent per dozen cheaper by automatic machines. The study also revealed that the fully automatic machines were practically one-half cent cheaper than the semi-automatic.

INFLUENCE OF TECHNOLOGICAL DEVELOPMENT ON THE HANDLING OF
VIRGINIA GRADE-A MILKR. F. Hutcheson; *Virginia Department of Agriculture*

22. Since the 1930's, there has been a tremendous development of machinery and equipment to handle and process milk. Improved equipment and better methods have changed the milk production, processing, and marketing problems from a local situation to one that covers the entire

state of Virginia and extends several hundred miles beyond. Nearly 90 per cent of Virginia's grade-A milk is cooled and stored in bulk tanks, and 25 per cent of it is handled by pipe-line milkers. Raw milk is moved daily over 400 miles in bulk tanks. Most of the grade-A milk is standardized for butterfat content and flavor, and is homogenized before bottling. Improved pasteurization, improved refrigeration, and improved transportation is rapidly changing the milk market pattern to where it is paralleling eggs, fresh vegetables, fish, and meats as a product normally purchased along with canned goods and the rest of the groceries on the housewife's list.

SECTION OF ASTRONOMY, MATHEMATICS AND PHYSICS

AN ULTRA-HIGH VACUUM SYSTEM FOR THE DEPOSITION OF THIN METALLIC FILMS

Calvin O. Tiller; *Virginia Institute for Scientific Research*

1. An ultra-high vacuum system has been constructed that will allow a thin metallic film to be deposited by evaporation at pressures less than 10-8 mm of Hg. The Alpert techniques for obtaining pressures in the 10-10 mm of Hg range have been followed.

STRUCTURES OF AG FILMS DEPOSITED ON A SINGLE CRYSTAL OF NaCl (work done at the Virginia Institute for Scientific Research)

Billy W. Sloope; *University of Richmond*

2. The conditions of formation of good single crystal films of Ag deposited on freshly cleaved NaCl surfaces are discussed in terms of pre-heat annealing of the substrate, post-heat annealing of the films and deposition temperature. Structures of these films were determined by transmission electron diffraction and glancing angle X-ray techniques. The effects of heat treatment on the agglomeration of the film and their structure are shown.

AN APPARATUS FOR MEASURING THE ANGULAR DISTRIBUTION OF THE TWO-GAMMA ANNIHILATION OF POSITRONS

William C. Doughty; *Hampden-Sydney College*

3. The angular distribution of the two-gamma annihilation of positrons in matter is thought to depend on the density and the identity of the matter; moreover, a knowledge of this angular distribution for a given sample can be used as a source of information about the interior of the

sample. The instrument described has as its essential components two scintillation type gamma-ray detectors and a mechanical device for changing the relative positions of the detectors.

POSITRON ANNIHILATION IN SODIUM, MAGNESIUM, AND ALUMINUM

Roger S. Cortesi; *University of Virginia*

4. Two photon angular correlation data from the annihilation of positrons in sodium, magnesium, and aluminum are given. The Parabolic portion of the curves is fitted to a parabola, and from this the momentum at the surface of the Fermi sphere is measured, and the percentage of positron annihilating with conduction electrons is estimated. The results are given below with the Fermi surface results compared to a simple electron density calculation.

Momentum at the Fermi surface in units of $mc \times 10^{-3}$

	Na	Mg	Al
Exp	3.6	5.4	6.8
Theory	3.5	5.2	6.7

Percentage of positron annihilating with conduction electrons

Na	Mg	Al
68	79	85

A LOW TEMPERATURE COOLING STAGE

James Wilkins and T. E. Leinhardt; *Virginia Polytechnic Institute*

5. A device for performing low temperature optical experiments is mounted in a Dewar flask containing liquid nitrogen. Liquid and vapor from the flask is directed through a vacuum jacketed stainless steel tube to the base of a copper stage. The vapor part of the stage to which specimens can be mounted is in an evacuated region. After flowing from the base of this stage the cooling vapors are directed through a series of concentric stainless steel tubes surrounding the copper stage. The vapors are exhausted through a small valve. For fast cooling a pump may be used. In tests temperatures between 300°K . and 80°K . were maintained with good stability.

FAR-INFRARED SPECTROMETER FOR WORK AT LOW TEMPERATURES

Robert J. Bell and T. E. Leinhardt; *Virginia Polytechnic Institute*

6. An Ebert-Fastie type spectrometer for low temperature research in the wavelength region 300 to 2500 microns is described for expected

resolution $R = \frac{\lambda}{d\lambda} = 10^4$. The system can be used for solid, liquid, and gas phase sample studies over wide temperature ranges. By symmetry arrangements spherical aberration and astigmatism are greatly reduced. Ground plate reflection filters are employed to eliminate higher order wavelengths, and a sensitive thermopile of expected sensitivity of 10^{-12} watts is considered as a detector.

$\frac{\text{cm}^2}{\text{cm}^2}$

URANIUM UPTAKE IN NUCLEAR EMULSIONS

Richard E. Garrett; *Hollins College*

7. The number of uranium atoms per unit volume of several types of nuclear emulsions loaded at different pH values is determined by counting the alpha tracks in the emulsion due to the decay of the uranium. The type C emulsion shows a constant uptake for pH values from 4.5 to 7.5 while the L type emulsion show marked dependence on pH for a given uptake.

THE MEASUREMENT OF THE ELECTRON AND OTHER SMALL CHARGES BY THE MAGNETIC BALANCE METHOD

J. W. Beams; *University of Virginia*

8. The magnetic balance method will measure masses to the order of one part in 10^6 even for extremely small ferromagnetic masses. The electrical charges on a small magnetically suspended particle in a vacuum may be determined by applying an electrical field and determining the resulting force on the particle by the magnetic support. The precision obtained for the charge on the electron should be greater than that obtained by the classical Milliken oil drop method. The possibility of testing the Lyttleton and Bondi hypothesis that the charges on the proton differs by a small amount from that of the electron is discussed. (Supported by Bur. Ord. U. S. Navy).

TRANSVERSAL DOPPLER SHIFT USING THE MOSSBAUER EFFECT

J. W. Beams and S. Berko; *University of Virginia*

9. The progress of an experiment designed to test the second order Doppler shift to a high degree of accuracy is described. The experiment consists of measuring the resonance absorption of the 14.4 Kev gamma line from Fe^{57} , deposited at the center of an air driven specially designed ultracentrifuge, in an iron foil supported at the periphery of the centrifuge. The centrifuge is designed to obtain peripheral speeds

of 4×10^4 cm/sec. The results of the calibration of the system to obtain the shape of the Mossbauer line will also be presented.

MOLECULAR WEIGHTS

R. D. Boyle and P. E. Hexmer; *University of Virginia*

10. A method is described for measuring molecular weights of organic compounds including insulin by the equilibrium ultracentrifuge method. A magnetically suspended rotor is operated in a vacuum system at constant temperature and speed for extended periods of time. The system measures molecular weights to a degree of accuracy of 1 part in 10^3 . (Supported by the National Science Foundation)

PRODUCTION OF HIGH VACUA WITH A MAGNETICALLY SUPPORTED CENTRIFUGE

C. E. Williams; *University of Virginia*

11. A magnetically supported rotor is scaled in a chamber free of lubricants and the pressure is lowered until the mean free path is large compared to geometrical distances inside the chamber. Molecular pumping as a function of peripheral velocity is discussed. (Supported by Office of Ordnance Research of the Army and Navy Bureau of Ordnance.)

PHOTONEUTRON CROSS SECTIONS FOR COBALT AND MANGANESE

P. A. Flournoy, R. S. Tickle, and W. D. Whitehead; *University of Virginia*

12. The total photonutron yields for Mn^{55} and Co^{59} were carefully measured from threshold to approximately 30 Mev. Analysis of these data using the Leiss-Penfold matrix indicates that the cross sections for both elements show a splitting in the giant resonance region in accord with the predictions of the classical hydrodynamic model. The Mn^{55} peaks occur at energies of $16.8 \pm .25$ Mev and $19.75 \pm .25$ Mev corresponding to cross sections of 90 mb and 77 mb respectively. Co^{59} maxima occur at $16.5 \pm .25$ Mev and $19.0 \pm .25$ Mev with cross sections of 109 mb and 92 mb. The cross sections $\sigma(\gamma, n) + \sigma(\gamma, 2n) + \sigma(\gamma, np) + \dots$ integrated to 25 Mev are 627 Mev-mb for Mn^{55} and 709 Mev-mb for Co^{59} . Breit-Wigner resonance lines were fitted to both cross sections and the intrinsic quadrupole moments determined from these fits are $+.78 \pm .11$ barns for cobalt. (Supported by the Air Force Office of Scientific Research).

SOME USES OF PULSED NEUTRONS IN REACTOR PHYSICS

L. S. Anthony, J. L. McClure, and Andrew Robeson;
Virginia Polytechnic Institute

13. In recent years, steady state measurements with neutron sources have been superseded by modulated or pulsed neutron sources. Descriptions of some of the applications of pulsed neutron technique to nuclear and reactor physics are given, with emphasis on the types of experiments planned for the V.P.I. 250 kilovolt Cockcroft-Walton accelerator.

AN ACCELERATOR FOR PRODUCING NEUTRON PULSES

J. L. McClure, L. S. Anthony, and Andrew Robeson;
Virginia Polytechnic Institute

14. A Cockcroft-Walton accelerator to produce neutron pulses of moderately high intensities has been built at Virginia Polytechnic Institute. The high voltage supply, a continuously variable voltage doubler circuit, will deliver a maximum of 2 ma. at 250 KV. Neutrons are produced using the $D(d, n) He^3$ reaction and pulses obtained by sweeping the deuteron beam from r.f. ion source across an exit port with electrostatic deflection plates. The entire system is mounted on casters to provide a reasonable degree of flexibility. A single channel variable-gate timing circuit, triggered by a pulse from the target, is used to measure time dependent neutron intensities in moderator materials. A fast twenty channel system is under construction. Experiments are underway to verify time dependent neutron distributions predicted by Monte Carlo computations on an IBM 650 computer. (A. E. C. Fellow in Nuclear Science and Engineering).

A MONTE CARLO ANALYSIS OF NEUTRON THERMALIZATION IN GRAPHITE

P. A. Newman and W. B. Payne; *Virginia Polytechnic Institute*

15. In conjunction with the pulsed neutron project at V.P.I., a Monte Carlo model has been prepared to give energy and spacial neutron distributions in a block of reactor grade graphite. Slowing down time and Fermi age are determined and the energy - time neutron distributions agree well with those of Marshak. The IBM 650 computer in the V.P.I. Computation Laboratory was used for this analysis.

THE DESIGN AND CONSTRUCTION OF A SINGLE CHANNEL TIME ANALYZER

W. D. Beasley and W. B. Payne; *Virginia Polytechnic Institute*

16. A single channel time analyzer was constructed which will detect

the pulse of beam current on the target of a Cockroft-Walton accelerator and, after a fixed delay time will open a channel to record the pulses from a detector. The delay time was continuously variable from 10 microseconds to 100 milliseconds. The duration of the counting interval was continuously variable from 10 microseconds to 10 milliseconds. The time analyzer is used in conjunction with the pulsed neutron program at V.P.I.

A MILLIMICROSECOND TIME-OF-FLIGHT NEUTRON SPECTROMETER

C. I. Hudson, Jr. and W. S. Walker; *University of Virginia*

17. A fast neutron time-of-flight spectrometer was developed to measure the flight time of $T(d,n)$ He^4 neutrons elastically and inelastically scattered from various nuclei. The associated particle method was used to obtain a zero time signal and to reduce background. Energy resolution and limitations of the spectrometer are discussed.

MEASUREMENT OF THE INTERNAL FIELD IN A FERROMAGNET USING POLARIZED NEUTRONS

T. G. Williamson; *University of Virginia*

18. The internal magnetic field in a ferromagnet was determined by measuring the change in the vertical component of polarization of a beam of polarized 3.4 Mev neutrons which had passed through magnetized iron. The beam of polarized neutrons was obtained from the $D(d,n)$ He^3 reaction using 1.0 Mev deuterons on a heavy ice target in a Van de Graaf accelerator. The polarization was found from the right-left asymmetry produced by scattering the beam from a carbon analyser. The ferromagnetic substance through which the beam was passed was a 6.7 cm thick piece of vanadium permendur (49% Fe, 49% Co, 2% V) which was placed between the poles of an electromagnet. The magnetic flux density in the permendur was determined by standard ballistic galvanometric techniques and within experimental error agreed with that calculated from the depolarization produced. Thus, within experimental error, the field effective for precessing the spins of fast neutrons is the magnetic flux density B . (Supported by the U. S. Atomic Energy Commission and the U. S. Army Office of Ordinance Research.).

PULSE SHAPE DISCRIMINATION AGAINST GAMMA RAYS

H. Funsten; *University of Virginia*

19. A circuit to discriminate between proton and electron scintillations in organic phosphors was built, utilizing saturation between the last dynode and anode of an RCA 6810-A photomultiplier tube. The circuit

was based on the apparent difference in second component decay amplitudes under proton and electron excitation, and achieved a discrimination ratio of around 4,000-1.

SCATTERING OF 3.4-MEV POLARIZED NEUTRONS FROM S, CU, AND ZN

G. C. Cobb, H. O. Funsten, and T. G. Williamson; *University of Virginia*

20. Partially polarized 3.4-Mev neutrons were elastically scattered by S, Cu, and Zn and the right-left asymmetry observed at approximately 15° intervals from 30° to 135° . Using the average polarization of the incident neutrons, ($P_n = -11.5\%$), the elastic scattering polarization of the scatterers, $P_{sc}(\theta)$, was determined for the above elements. The observed polarizations are compared with recently measured differential cross sections. The observed values of polarization for Cu and Zn are similar at all scattering angles as are their differential cross sections. Maximum polarization for these elements occurs at an angle of about 120° and in all three cases is about 35%. (Supported by the U. S. Army Office of Ordnance Research and U. S. Atomic Energy Comm.)

THE THEORY OF ELEMENTARY PROCESSES

Dr. Claude Marmasse; *Hollins College*

21. This theory, developed in France since 1956, is fundamentally concerned with a statistical approach to the phenomena involved in collective (or multiple) reactions, this last term being understood in its widest sense. When applied to the case of polyelectrolytes, it enables one to prove theoretically the existence of sites of preferential fixation now proved experimentally and it explains the behavior of certain experimental curves (e.g. pk^2 versus length of the chain). The axiomatic presentation is developed.

SCINTILLATION OF SATELLITE RADIO SIGNALS

James D. Lawrence, Jr.; *University of Virginia*

22. Signals from satellite 1959 Iota recorded over a six month period have been analyzed to determine presence of scintillation. Marked night-time scintillation is frequently noted; day-time scintillation is only weakly, if at all, observed. The appearance of scintillation of the satellite signal shows an almost one to one correspondence with the occurrence of scintillation of the radio source in Cassiopeia at 39 mcs. There is some evidence of the southern latitude limit of the layers responsible scintillation previously described by Swenson and Yeh.

In addition, the records indicated above have been analyzed to determine a fading rate of the satellite signal. Since many unknown modula-

tions appear on the 20 mc signal of 1959 Iota, a fading rate has been difficult to determine. In certain instances a fading rate of several cycles per second is evident which is in agreement with results previously announced.

ANGULAR SCINTILLATIONS OF RADIO STARS

James Hollinger; *University of Virginia*

23. Equipment and procedure used in making measurements of the phase scintillations imposed by the ionosphere on radiation from a radio star are described. Measurements were made at 81.5 mc/sec. with a phase switched interferometer which had an aerial separation of 95 wave lengths. Results showed irregularities in phase of two types: (a) random irregularities with a magnitude of 2-3 minutes of arc which correlated well with amplitude scintillations (b) total shifts in phase of up to 7-8 minutes of arc which persisted for periods of up to $\frac{3}{4}$ of an hour.

A NEW LOOK AT PERTURBATION IN CELESTIAL MECHANICS

D. Willard; *Virginia Polytechnic Institute*

24. Experience has shown that students with a background in physics appreciate an approach to the equations of perturbed planetary motion more direct than that which is available in celestial mechanics texts. Such a presentation is described here, leading to equations of the form

$$\frac{d\mathbf{A}}{dt} = \omega \times \mathbf{A}$$

Where \mathbf{A} is any unit vector and ω a function of the perturbing force which has two advantages: (a) it displays the effects of an arbitrary force without reference to any particular coordinate system and (b) it can be rapidly computed by machine techniques.

ATMOSPHERIC PHENOMENA AT A SUNRISE TOTAL ECLIPSE OF THE SUN

John W. Stewart; *University of Virginia*

25. The author and his father traveled to Massachusetts in order to observe the sunrise total solar eclipse of 2 October 1959. Unfortunately heavy clouds prevented a view of the eclipse itself, but the phenomenon was nevertheless quite striking. As totality approached the general illumination faded gradually as if by the dimming of the house lights of a gigantic theater. By contrast at the end of totality the light returned abruptly as the moon's shadow "went to the ground." During the seconds of totality a clear patch of sky on the western horizon

unexpectedly turned a deep red color. Apparently this effect has not been reported at previous eclipses.

RECENT HIGH PRESSURE STUDIES OF SOLIDIFIED GASES

John W. Stewart and James N. Boyd; *University of Virginia*

26. Compressibilities at constant temperatures for solidified H_2S and SiF_4 have been determined over the range in pressure 0–20,000 atmospheres. Direct piston displacement technique was used. First order phase transitions appear as discontinuities in the volume; second order transitions appear as discontinuities in $(dV/dP)_T$. H_2S exhibits three solid phases. The transitions occur at 103.6°K and 126.2°K at atmospheric pressure. The pressure-volume phase diagram was obtained. SiF_4 shows three solid phases. The triple point was extrapolated to be at 123° K, 11,200 kg/cm². Solidified SiH_4 is being studied at present. The pressure apparatus and the temperature control system are described.

APPARATUS FOR THE MEASUREMENT OF THE MAGNETIC ROTATION SPECTRA OF FREE RADICALS PRODUCED BY FLASH PHOTOLYSIS

J. L. Detch, L. Goodfriend, and F. R. Crownfield;
The College of William and Mary

27. Apparatus is described which will be used for detecting changes in the Faraday Rotation of a gas when free radicals are produced in it by flash photolysis. The plane of polarization of light passed by a Glan-Thompson prism is rotated by the gas in a magnetic field. This light is extinguished by a second Glan-Thompson prism in the absence of free radicals. The increase in transmission when the gas is exposed to a brief, high intensity flash produced by discharging a capacitor through a Xenon tube or exploding a wire is detected by a photoelectric or photomultiplier cell. (Support given this project by The Research Corporation.)

A DEMONSTRATION OF PHASE AND GROUP VELOCITIES USING A CATHODE RAY OSCILLOSCOPE

F. R. Crownfield, Jr.; *College of William and Mary*

28. A method of displaying two travelling waves of different wavelengths and velocities on an oscilloscope is described. Next, it is shown how to produce the superposition of these waves and display the fact that the resulting waves and their envelope travel at different velocities. Finally, a graphical method of determining these velocities (the phase and group velocities respectively) from those of the component waves is presented.

USE OF A SHOE X-RAY MACHINE FOR AN UNDERGRADUATE LABORATORY
IN ATOMIC PHYSICSJ. W. Little; *The College of William and Mary*

29. A "retired" shoe X-ray machine was used for experiments to be performed in undergraduate laboratory. Laue spots of several crystalline materials were obtained in about ten minutes exposure. Double scattering from carbon blocks demonstrated the polarization of the radiation. The radiation was detected in a Geiger tube. Satisfactory counting statistics were obtained in fifteen seconds. Since this machine has an on time of about thirty seconds, the timing cycle did not have to be changed.

AN UNDERGRADUATE NUCLEAR PHYSICS EXPERIMENT ON THE SPECTRUM
OF A BETA EMITTERL. Rogon, and J. L. Detch; *The College of William and Mary*

30. This paper presents an experiment on Beta decay which can be performed in an undergraduate laboratory. The pulse height spectrum of a Beta emitter ($_{81}\text{Ti}^{204}$) was obtained by means of a plastic scintillator, cemented from two pieces, with the source in between. Calibration was made assuming a linear relation between the pulse height and energy, and using the Compton recoil electron spectrum from Ba^{137} 0.661 Kev gamma ray. Tables of the Fermi function were used to make a Fermi (Kurie) plot to determine the end point energy and verify the Fermi theory. Suggestions are made as to the qualities desired in a source of Beta rays for this experiment, in order to simplify interpretation and improve the accuracy.

A GENERAL PHYSICS LABORATORY EXPERIMENT OF THE BLAMER SERIES
OF HYDROGENR. E. Adelberger; *The College of William and Mary*

31. A simple grating spectrometer suitable for home construction is described, together with its use in determining the Rydberg constant from the Hydrogen ($\text{H}\alpha$, $\text{H}\beta$, $\text{H}\gamma$) spectrum. Three lenses, a slit, and an inexpensive plane replica grating are used, with a simple linkage which gives scale readings proportional to wavelength.

SECTION OF BACTERIOLOGY

INCIDENCE OF BACTERIAL SPECIES ISOLATED FROM URINARY TRACT INFECTIONS

H. J. Welshimer; *Medical College of Virginia*

1. Of the 200 bacterial isolants cultured from the urinary tract of 173 patients, *Escherichia coli* was found to be the most frequently occurring organism and was isolated 66 times. Aerobic streptococci, *Aerobacter aerogenes*, *Proteus vulgaris*, and *Pseudomonas aeruginosa* were isolated 33, 27, 26 and 24 times respectively. Nine other species were isolated in 1 to 7 instances. Although the urinary tract infections were most frequent in females, the number of mixed infections were proportionately higher in males than in females.

A TECHNIQUE TO PROCURE LUNG MACROPHAGES

Eva Soto Leake; *University of Virginia*

2. Rabbit lung macrophages can be easily procured by washing them out with balanced salt solution injected into the trachea. An average of 0.1 to 0.2 ml. of packed cells is obtained from the lung of a normal rabbit. The population of cells is homogeneous, the contamination with red blood cells is minimal, and their viability exceeds 90%. These macrophages are able to engulf heat killed tubercle bacilli when tested for phagocytosis in tissue culture. Cells resembling rabbit lung macrophages were washed out from the lungs of mice, rats and guinea pigs.

HISTOBACTERIOLOGY, THE STUDY AND IDENTIFICATION OF MICROORGANISMS IN FIXED TISSUE BY FLUORESCENT ANTIBODIES

J. D. Marshall and P. Arne Hansen; *Armed Forces Institute of Pathology, Washington, D. C., and Microbiology Department, University of Maryland, College Park.*

3. The feasibility of using the fluorescent antibody technic to differentiate several closely related bacterial species in formalin fixed paraffin embedded tissues was studied. Animals were experimentally infected with *Pasteurella anatipestifer*, *P. multocida*, *P. novicida*, *P. pestis*, *P. pseudotuberculosis*, and *P. tularensis*. Tissues were taken at autopsy and processed for routine histological examination. Unstained sections were treated with fluorescein conjugated immune sera prepared against each species of *Pasteurella* and examined by ultraviolet microscopy. Organisms and masses of degenerative antigenic material within the tissues stained brightly when homologous serum was used, but not when heterologous sera were

used. In lesions containing 2 or more species of bacteria, differentiating the species under investigation was not difficult. Correlation between specific histological changes, with a single species of bacteria was possible.

TUBERCULOSTATIC ACTIVITY OF ALVEOLAR MACROPHAGES

Shunsaku Oshima; *University of Virginia, School of Medicine*

4. This report describes some studies on the extracts obtained from the macrophages washed out of the lungs of vaccinated-challenged rabbits including the tuberculostatic activity of these extracts and purification studies on carboxy-methyl cellulose columns. These data indicate that the main tuberculostatic factor in the lung macrophage extracts appears to be lysozyme.

THE USE OF IODINE FOR THE DISINFECTION OF INDOOR SWIMMING POOLS

J. E. Faber, J. D. Marshall, and William Campbell; *University of Maryland*

5. An 18-week investigation comparing chlorine and iodine disinfection of indoor pool water was conducted. Free and available chlorines, 0.0 to 2.0 ppm, gave a coliform MPN of 240/100 ml to 0/100 ml and plate counts as high as 1380/ml. Minimal iodine in the presence of free and available chlorine yielded no coliforms, no fecal streptococci, and minimal total plate counts. With a deck drain cross-connection introduced, counts ranged to 2400/ml. Free iodine levels from 1.0 to 4.0 ppm yielded no coliforms, no fecal streptococci and negative plates. With the cross-connection, up to 70/ml total counts were obtained. Normal iodine levels from 0.4 to 0.8 ppm permitted no coliform, no fecal streptococci, and total counts from 0 to 106/ml. With the cross-connection, the count rose to 3100/ml. A power failure stopped the recirculation system for 24 hours permitting an inadvertent positive contamination control, resulting in a coliform MPN at 240/100 ml; fecal streptococci, MPN at 10/100 ml; and total counts, TNC. The lack of eye and nose irritation during iodine disinfection schedules was statistically significant. Sixty percent of those polled preferred iodine treatment, 10 percent preferred chlorination, and the remainder indicated no preference.

THE PROPERTIES OF A STRAIN OF HERPES SIMPLEX VIRUS WHICH PRODUCED UNUSUALLY LARGE MULTINUCLEATED GIANT CELLS IN TISSUE CULTURE

Clayton E. Wheeler and Charles M. Canby;

University of Virginia, School of Medicine

6. During the course of a previous experiment which involved growing HF herpes-infected HeLa cells in human serum containing antibody to the herpes simplex virus, the character of the plaque formed by the virus in one set of cultures had changed. A plaque composed of very large multinucleated giant cells was constantly produced instead of the usual small giant cell plaque. The new strain of virus, designated HPF, is immunologically identical with the original HF virus. The HPF strain produced mild, barely demonstrable keratitis without encephalitis in rabbits whereas the original HF strain produces severe kerato-conjunctivitis with encephalitis which is often fatal. Rabbits can be immunized against the virulent HF strain by using the relatively nonvirulent HPF variant. HPF is less virulent than HF when treated by intracerebral inoculation in mice. Other properties of the HPF strain will be presented. It is thought the HPF strain may be useful in immunologic procedures and genetic studies.

SECTION OF BIOLOGY

THE BLESSED THISTLE (*Cnicus benedictus*, L.) IN VIRGINIA

A. B. Massey; *Virginia Polytechnic Institute*

1. The blessed thistle, of the family Compositae, is an introduction from Europe. Fernald (Rhodora 46:158) questioned the persistence of it in Virginia and its inclusion in the flora of the State. He found it in a field near Petersburg one season but not in the following year.

We have specimens in the V. P. I. Herbarium collected from April to July in Buckingham, Westmoreland, Albemarle, Shenandoah, Nansemond, Henrico, Accomac, Mecklenburg and Amherst (2 collection 1944, 1947 from same farm) Counties. Fernald records it in Dinwiddie County. Rosette stages in dormant season from Accomac (December) and Franklin (October) Counties are in the Herbarium. The species has been known in Virginia for more than 30 years; however, the oldest specimen in the V. P. I. Herbarium dates back to 1944.

It is very evident that the species has become well naturalized in Virginia and can properly be included in the flora of the State. The range as given in Grays Manual 8th Ed is "Roadside and waste places, rare, N. B. to Ill., and southwest."

A *Zephyranthes* COMPLEX OF THE MEXICAN PLATEAU

Raymond O. Flag; *The Blandy Experimental Farm*

2. A *Zephyranthes* complex in the mountainous area of central Mexico

is best known from collections in the State of San Luis Potosi. Examinations of plants collected by Mr. and Mrs. Moris Clint and of others collected by W. S. Flory indicate a close affinity between *Z. clintiae* and *Z. Fosteri*. *Zephyranthes erubescens*, *Z. Lindleyana*, *Z. macrosiphon* and other taxa seem to be involved. Hybridization, introgression and possibly polyploidy and apomixis have played major roles in the development of this complex.

A 60-CHROMOSOMED *Allium* FROM TEXAS

W. S. Flory and Rina Varma; *The Blandy Experimental Farm, University of Virginia*

3. *Allium Coryi* M. E. Jones is a yellow-flowered onion from the mountains of Trans-Pecos Texas with 60 somatic chromosomes. This is a new number for the genus, and one of the largest chromosome numbers known for *Allium*. The chromosomes vary from just under 2 to just over 6 microns in length, mostly from 4 to 6 microns long. Four pairs, including the longest and the shortest ones, have centromeres that are nearly median in position. The others have centromeres that vary from submedian to almost subterminal in location.

THE GENUS *Beaucarnea*: (1) CHROMOSOMES AND (2) SYSTEMATIC POSITION

W. S. Flory and Rina Varma; *The Blandy Experimental Farm, University of Virginia*

4. Three representatives of *Beaucarnea* Lem. (*Nolina* Michx.) have each been found to have 38 somatic chromosomes. These vary from about 2 to well over 7 microns in length. Several of them are decidedly longer than the others. The numbers, and to some extent the make-up of the chromosome complements, are reminiscent of the cytological set-up in certain of the Agavaceae. These factors, coupled with morphological characters, and habitat indicate the genus as being more correctly placed in Agavaceae than in Liliaceae.

SOME PROPERTIES OF A GROWTH INFLUENCING SUBSTANCE IN TIMOTHY ROOTS

Robert T. Brumfield; *Longwood College and Oak Ridge National Laboratory*

5. The root cap of timothy roots is covered by a transparent gelatinous substance which has certain growth effects. Water extracts of the substance modify the absorption spectrum of indole-3-acetic acid, possibly by the formation of a new complex, and the magnitude of the shift is influenced by UV in proportion to the dosage. The spectrum of 2,4,

6-trichlorophenoxyacetic acid is modified when mixed with extracts of the substance but the shift is not influenced by UV. These results are of interest since 2,4,6-T inhibits the growth effects of UV while IAA does not. (Supported by the Atomic Energy Commission and the National Science Foundation).

DO WE NEED A GEOBIOTIC ETHIC?

Joseph J. Shomon; *Commisison of Game and Inland Fisheries*

6. The concept of a geobiotic ethic, its meannig, importance, and need is introduced. Such topics as our dwindling natural resources, the growing and shifting human population and its wants, and the necessity of preserving some semblance of our natural environment in an ever increasing technological social order are treated. To maintain balanced order, it seems apparent to some, but not many, that we stand to lose much that is democratic and American unless we evoke and ever enlarge a genuine ecological conscience in our people. Those in the scientific, educational, and other professional fields can do much to bring this about.

PRELIMINARY STUDIES ON THE FEEDING RESPONSE OF REDWINGS TO 27 GRAIN SORGHUM VARIETIES

Paul W. Lefebvre; *Virginia Polytechnic Institute*

7. Tests were conducted to determine whether a technique designed to test corn resistance to blackbird attack could be modified for use in finding grain sorghum varieties which might be so resistant. Use of the modified technique in preliminary tests seems to indicate that the procedure is effective and that several varieties of grain sorghum are bird-resistant to varying degrees.

EVALUATING RABBIT MANAGEMENT PROCEDURES BY PELLET COUNTS

Alan S. Krug; *Virginia Polytechnic Institute*

8. Summer utilization by the cottontail rabbit of various areas receiving different land-cultural treatment was measured by pellet counts. Following this, a study was instituted to determine the longevity of pellets and the effect that this longevity would have on land-cultural treatment evaluations done later in the year. It was found that pellet counts in late fall and winter are markedly influenced by pellets deposited earlier in the season, and such counts may therefore give erroneous impressions.

DEVELOPING A TECHNIQUE FOR SAMPLING BROWSE PRODUCTION ON DEER RANGES

Jim B. Whelan; *Virginia Polytechnic Institute*

9. A study concerned with the development of a weight technique for sampling the quantity of browse available to the White-tailed Deer. The problem objective was to determine correlation between quantity of available browse and site quality measurements. At present, clipping and weighing the annual growth of browse plants on sample plots is the most accurate means of determining production and yield. On sample plots if a significant correlation exists between weights of browse clippings and several measures of site quality, then these site quality measurements by themselves could serve as a reliable estimate of the browse yield.

VARIATIONS IN THE CRAYFISH *Cambarus montanus acuminatus*Lary L. Farmer; *University of Virginia*

10. Studies of variation of selected body parts were made using the Student's t-test and the analysis of variance test. From this data relatively smooth north-south and east-west clines could be established for each of the measurements taken. Previously those populations occurring in the eastern part of the range had been considered a different subspecies from those in the western part of the range. Since no definite breaks occur in the clines, this designation is considered invalid.

FUNCTION OF THE CILIATE MICRONUCLEUS DURING ASEXUAL REPRODUCTION

Carolyn Wells; *Longwood College*

11. X-Irradiation studies of strain EU 6000, *Tetranymena pyriformis*, indicate that the recovery of viable amiconucleate clonal populations is rare although many amiconucleate cells are found among surviving progeny. Attempts to introduce micronuclei into cells of a radiation-produced amiconucleate clone by conjugation have been made. Micronucleate lines are obtained from amiconucleate pair members only in low frequency. The results, considered with those of other workers, suggest that some change in the state of the cell, additional to the physical loss (or gain) of the micronucleus, must occur before viable amiconucleate clones can be obtained from micronucleate cells, or before amiconucleate cells can produce viable micronucleate lineages. The results further imply that the ciliate micronucleus unquestionably contributes information to the cell during asexual growth and reproduction. (Work performed at the Biology Division, Oak Ridge National Laboratory).

RESISTANCE TO DDT AND CHLORDANE IN THE GERMAN COCKROACH FOLLOWING DISCONTINUANCE AND RESTORATION OF SELECTION

James McD. Grayson; *Virginia Polytechnic Institute*

12. Discontinuance of selection resulted in initial apparent rise in resistance in both strains, followed by rapid loss of resistance after third generation in DDT strain but slow, gradual loss in chlordane strain. Restoration of selection resulted in rapid increase in resistance in chlordane strain but slow increase in DDT strain.

THE ALBINISTIC ISOPODS OF THE UNITED STATES

Harrison Ross Steeves III; *University of Virginia*

13. The distribution of the albinistic isopods is both widespread and at the same time peculiarly limited. The characteristic habitat is a limestone cave with a sufficient water supply. Due to new evidence, the albinistic isopods have now been placed in the Genus *Asellus*. The present system of classification is almost entirely based upon the secondary sexual characteristics of the tip of the endopodite of the second pleopod and the armament of the palmar region of the propodus of the male gnathopod.

A STUDY OF THE MICROENVIRONMENT IN TWO CONTRASTED FOREST FLOOR HABITATS

James K. Grimm; *Madison College*

14. A study of the microenvironment in two contrasted forest floor habitats was made to determine the microenvironmental factors. With special reference to gradients, as well as to averages and extremes, the conditions or combination of conditions operating to control the population of the organisms under investigation were also determined. Various mechanical devices were used to record the physical factors which tend to regulate the activities of the organisms found in the litter of the areas investigated. Samples of leaf litter were taken daily and the organisms extracted to determine kinds and numbers found under varying physical elements.

GASTROTRICHAN STUDIES AT MOUNTAIN LAKE BIOLOGICAL STATION,
GILES COUNTY, VIRGINIA, JUNE-AUGUST 1958

Charles E. Paekard; *Randolph-Macon College*

15. One hundred and seventy-six individual specimens were isolated from samples of numerous collections from widely different sites in Vir-

ginia and West Virginia with morphological, developmental and ecological data taken. Representatives of the genus *Chaetonotus* were most abundant. *Ichthyidium*, *Lepidodermella*, *Polymerurus*, and *Heterolepidoderma* were less prevalent. Many stations yielded no individuals at all. Mountain Lake itself and Farrier's Pond near Newport had fairly rich faunas. The investigation constitutes what is planned as an extensive coverage of gastrotrichs for these two states.

MORPHOGENESIS OF PET/MCV MOUSE MELANOCYTES

Willie M. Reams, Jr. and Stuart E. Nichols, Jr.;

Medical College of Virginia

16. The pigment cells found in the connective tissues of PET/MCV mouse embryos generally begin melanogenesis well before they have assumed their definitive dendritic shape. In contrast to the melanocytes within the skin, these internal melanocytes readily lend themselves to experimental investigation. The data obtained from grafting interal melanocytes into chick embryos suggests that the morphogenesis of pigment cells is brought about by a mechanism similar in its action to a hormone. A concept of morphogenetic hormones was proposed. (Supported in part by the National Institute of Health and by the National Science Foundation. *Medical Student Fellow of the National Foundation and U.S.P.H.S.)

THE EFFECT OF NA-L-THYROXINE ON VIABILITY AND REGENERATION OF *Dugesia tigrina*

William L. Mengebier; *Madison College*

17. Segments of *Dugesia tigrina*, formed by sectioning the animals through the mid-pharyngeal region, exhibited a reduced mortality rate when placed in 3.13×10^{-5} M Na-L-Thyroxine. Formation of the blastema and rates of regeneration of individual segments were increased by the addition of the thyroxine salt. Treatment with phenyl alanine had no effect on either the mortality rate or the regenerative process. The addition of cortison acetate inhibited regeneration and increased the mortality rate. The effects of vertebrate hormones on invertebrates was discussed.

HISTOLOGICAL OBSERVATIONS OF THE OVIDUCT OF *Cambarus longulus* *longulus* (GIRARD 1852)

D. Hugh Puckett; *College of William and Mary in Norfolk*

18. A study of the oviduct of *Cambarus l. longulus* (Girard 1852) revealed that changes associated with the reproductive cycle occur in the oviduct of this species. These changes involve differences in the his-

tological nature of the epithelium of the oviduct before and after egg laying marked by differences in the position of the nuclei, the secretory activity, and the nature of the limiting membranes of the epithelial cells. Various staining techniques indicate the presence of glycogen and other polysaccharides in the epithelial cells and in the lumen of the oviduct. A description of the connective tissue coat of the oviduct and oviducal orifice was presented.

T-1824 DYE LIGHT ABSORPTION CHARACTERISTICS IN DEPROTEINATED PLASMA

Jack D. Burke; *Department of Biology, University of Richmond*

19. The absorption spectra of two T-1824 (Evans Blue) dye solutions were determined on a Beckman Spectro-photometer in the wave-length range of 500 to 700 millimicrons. Wave-length was plotted against optical density. One absorption wave was determined on a dye in water solution. Another curve was determined on a deproteinated plasma sample tagged with the dye during blood volume determinations on swine. A comparison of the two curves portrayed graphically revealed a peak absorption at 620 millimicrons. Thus, the validity of blood volume determinations using T-1824 dye increases when this parameter is known and controlled at peak transmittance.

QO₂ STUDIES IN THE HORNED PASSALUS

James R. Powell; *University of Richmond*

20. The rate of oxygen consumption in a sample of *Passalus cornutus* Fabricius was measured in regard to body weight and expressed in terms of QO₂. QO₂ and body weight in *Passalus* were found to be related by the equation $QO_2 = (k) \text{ Body Weight}^{0.88}$ which is in accord with the surface law of Sarrus and Ramcaux.

SECTION OF CHEMISTRY

QUANTITATIVE DETERMINATION OF THE MAJOR POLYPHENOLS IN TOBACCO

Marvin D. Edmonds and W. Allan Powell, *Philip Morris, Inc. and University of Richmond*

1. A paper chromatographic method for the quantitative determination of individual polyphenols in tobacco was described. The polyphenols were measured spectrophotometrically as colored reaction products with Folin-Ciocalteu reagent. The colorimetric procedure depends upon the reduction of compounds containing hexavalent tungsten and molyb-

denum to colored compounds. The Folin-Ciocalteu reagent was chosen because it allows sensitive detection. It is a fast reactant and it allows one to overcome the interfering background problems obtained when using direct ultraviolet analysis for these compounds.

A STUDY OF THE REDUCING SUBSTANCES IN CIGARETTE SMOKE

J. E. Wickham, Jr., J. C. Holmes, and J. J. Westbrook, III;

Philip Morris Research Center

2. An automated method for the determination of total reducing substances, neutral reducing substances and acidic reducing substances in cigarette smoke was described. The method involves examination of the total particulate matter derived from cigarette smoke. Procedures and results were described for the treatment and examination of the total particulate matter so as to yield measurements of the various reducing substance fractions with practical precision.

A MATERIAL BALANCE STUDY OF A BURNING CIGARETTE

Elizabeth T. Oakley, Melvin B. Bennett, and Joseph C. Holmes;

Philip Morris Research Center

3. An apparatus and procedure were described for the collection and weighing of all the fractions of a cigarette smoked under standard smoking conditions. The fractions were defined as the butt, ash and smoke. The smoke was further fractionated into mainstream and sidestream particulate matter, carbon dioxide and other gases. The precision of replicate analyses was extremely good and the accuracy of the method was excellent .

THE DETERMINATION OF BORIC ACID BY CONDUCTIMETRIC MEASUREMENT

Carol A. Penn and Helen L. Whidden; *Randolph-Macon Woman's College*

4. Several methods described in literature for determining boric acid were either inapplicable for the desired concentration range (0 to 10 parts per million) or required too long an operation time. Addition of mannitol to boric acid converts it to a complex more highly ionized than boric acid and suited to conductimetric measurement. Measurements on several boric acid-mannitol solutions were made and a calibration curve (concentration versus conductance) was prepared. Preliminary results showed that boric acid can be determined quantitatively by this method. Details of experimental procedure were worked out by studying the following factors: (1) effect on conductance of varying excess amounts of mannitol, (2) the degree of ionization of the boric

acid-mannitol complex and (3) viscosity effects on conductance of the different complex concentrations.

A COMPARATIVE STUDY OF AVAILABLE TITRIMETRIC METHODS FOR URANIUM

Gayle King and Helen L. Whidden; *Randolph-Macon Woman's College*

5. The most commonly used volumetric method for determining uranium involves: (1) the reduction of uranium to a mixture of U(IV) and U(III) in a Jones reductor, conversion of the U(III) to U(IV) by aeration, addition of ferric ion to quantitatively convert U(IV) to U(VI), and subsequent titration of the resulting ferrous ion with standard potassium dichromate or ceric solutions; or (2) reduction of uranium to U(IV) in a lead reductor followed by titration with a standard ceric solution. A repetition of the procedures was carried out since investigators attempting to explain the varying titres and evaluate the methods arrived at different conclusions. Pure U_3O_8 samples were used to determine the dichromate and ceric titres. A comparison was made of the uniformity of results as to ease and accuracy and the methods were evaluated by analyzing the recovered uranium.

A NEW SPECTROPHOTOMETRIC METHOD FOR THE DETERMINATION OF MICROGRAM AMOUNTS OF MANGANESE

Dwight O. Miller and John H. Yoe; *University of Virginia*

6. The method is based on the absorbance of radiant energy by a complex which is formed by the reaction of manganese (II) with benzohydroxamic acid in an ammoniacal medium. The reaction conditions are critical and the determination may also be carried out in nonaqueous solvents. The sensitivity is 0.016 p.p.m. at $544\text{ m}\mu$ and at this wavelength, the reagent does not absorb, permitting a water blank to be used. An ion exchange technique was employed for the separation of interfering ions. The analysis of a variety of National Bureau of Standards samples and synthetic mixtures showed that the method is accurate. The probable structure of the absorbing species was discussed.

COMBUSTION OF ELEMENTAL BORON

Claude P. Talley; *Experiment Incorporated*

7. Boron rods of high purity were prepared and subsequently heated by electrical resistance heating in various gases, so that the burning rate could be measured under controlled conditions. Relatively slow reaction rates were followed by measuring volumetrically the uptake of oxidant gas at constant pressure as a function of time. Faster rates were

followed by measuring the change in dimensions with time of the solid boron as it was consumed. At high temperatures, combustion in pure oxygen and certain other gases was self-sustaining and electrical heating was not required after ignition. Various rate-limiting steps were indicated for the oxidation of elemental boron in pure oxygen over a wide range of temperature and pressure. In four different regions, transport of some species appeared to be the rate-limiting step, while in a fifth region, chemical reaction may have been the slow step. In two of the regions, transport by liquid flow or gas-phase diffusion of boron oxide was rate-limiting. In the other two regions, evaporation of elemental boron is expected to be rate-limiting in one case and diffusion of oxygen in the gas phase in the other case.

PREPARATION AND PROPERTIES OF MASSIVE AMORPHOUS ELEMENTAL BORON

Claude P. Talley, Lloyd E. Line, Jr., and Quinton D. Overman, Jr.;
Experiment Incorporated

8. Massive amorphous elemental boron was prepared by reduction of BBr_3 vapor by H_2 in the vicinity of an incandescent tungsten filament $25\ \mu$ in diameter. Information on the kinetics of the process was obtained. The deposition apparatus was constructed from Pyrex glass and Teflon fittings in order to prevent contamination from stopcock greases. Boron rods up to 2 mm in diameter and 5 to 10 centimeters in length were obtained. Boron deposits in the shapes of spheres, hemispheres and cones were also observed. Wet chemical analysis of a 1-mm-diameter rod for total boron indicated a boron content of 98.8%. This type of boron is called amorphous because X-ray diffraction patterns revealed only two diffuse rings. Amorphous boron rods showed high tensile strength and Young's modulus (2.3×10^5 to 3.5×10^5 lb/in.² and 64×10^6 lb/in.², respectively). The density was determined by a flotation technique and found to be $2.350\text{ gm/cm}^3 \pm 0.005\text{ gm/cm}^3$. This material is very hard and can scratch sapphire. Amorphous boron shows a relatively high resistivity and high negative temperature coefficient of electrical resistance, a characteristic of crystalline boron and semiconductors in general. It also is very opaque in the visible but can be crystallized by proper heat treatment into other modifications including one which transmits a considerable amount of red light.

ISOLATION AND CHARACTERIZATION OF GNAPHALICIN, AN ANTIBIOTIC I ISOLATED FROM *Gnaphalium obtusifolium* (RABBIT TOBACCO)

Samuel J. R. Gamble; *Lynchburg College*

9. An antibiotic principle was isolated from. *Gnaphalium obtusifolium*, commonly known as as Rabbit Tobacco. An ether extract of the leaves gave a water insoluble fraction which is active against *Bacillus subtilis*.

KINETICS OF THE HYDROLYSIS OF NITROSTYRENES

Thomas I. Crowell; *University of Virginia*

10. The reversal of the nitrostyrene synthesis proceeds through the nitroalcohol to aldehyde and nitromethane. Kinetic studies in aqueous buffer solutions at 25°, in the pH range 1.5 to 8, showed consecutive first-order reactions. The first step, which is reversible, showed general base catalysis; however, the rate is not linear in the base concentration. The rate of the second step depends only on pH.

A TECHNIQUE FOR THE CONTINUOUS MEASUREMENT OF THE VAPOR PHASE CORROSION OF METALS

William H. Jago and Nelson F. Murphy; *Virginia Polytechnic Institute*

11. Two sensing systems were used in the continuous measurement of the vapor phase corrosion of metals: (1) a linear variable differential transformer (LVDT) and (2) a modified analytical balance. The LVDT functioned as an electro-mechanical transducer by the movement of a magnetic core which caused a voltage proportional to the core displacement to be produced in the secondary winding of the transformer. After calibration, the LVDT readings were recorded continuously on a strip chart. The left-hand pan support of an analytical balance served as the movable end of a glass rod second-class lever. After zeroing the balance, readings were taken from the milligram scale. The metallic samples were suspended either from the lower cantilever supporting the LVDT core or from the center of the glass rod lever. The essential features of the corrosion reactor were a three-necked, 500 milliliter flask submerged in a four-liter constant temperature bath, a glass strand from which the metallic samples were suspended and either a water-cooled condenser for atmospheric tests or a gas inlet reducer for special atmosphere tests. The bottoms of the metallic samples were suspended five centimeters above solutions which produced the desired corrosive vapors in the corrosion reactor.

SOLUBILITY AND EQUILIBRIUM RELATIONSHIPS IN THE SYSTEM WATER—PHOSPHORIC ACID—TRIBUTYL PHOSPHATE

Basil C. Doumas and Nelson F. Murphy; *Virginia Polytechnic Institute*

12. Mutual solubility and equilibrium tie-line data for the system water—phosphoric acid—tributyl phosphate were determined at $25.00 \pm 0.05^\circ\text{C}$. Tributyl phosphate was titrated into aqueous phosphoric acid solutions until a distinct organic layer was observed on top of the aqueous phases. The “semi-quantitative” water-rich solubility curve for the system was determined. Seven heterogeneous mixtures of water phosphoric acid and tributyl phosphate were equilibrated at $25.00 \pm 0.05^\circ\text{C}$. and separated

into coexisting phases. Phosphoric acid concentrations of organic and aqueous phases were determined by titration with standard NaOH solution. Organic phases were analyzed for water by titration with Karl Fischer reagent. The organic-rich solubility curve for the system was located by phosphoric acid and water analyses of equilibrium organic phases. The complete solubility curve for the system was not determined since 85 per cent phosphoric acid was used throughout the experimental work as the source of acid. Selectivity diagrams were drawn to show that tributyl phosphate is more selective for phosphoric acid than n-butanol, diethyl ether or 2-hydroxyethyl, n-hexyl ether. Of the four solvents mentioned, tributyl phosphate seems best for separation of phosphoric acid solutions by liquid-liquid extraction.

REPRESENTATION OF DELAY POWDER DATA

Lewis B. Johnson, Jr.; *University of Virginia*

13. A systematic representation of burning data for delay powders was found very useful for many systems. The "phase diagram representation" was followed. For two-component systems, composition was represented as the abscissa on rectangular coordinates and the function of interest as the ordinate. Three-component systems were represented on triangular composition diagrams. Lines of equal heat output were designated "isocals" and lines of equal burning times, "isochrons." Other functions can be represented similarly.

THE BINARY SYSTEM SODIUM ACETATE-PROPIONIC ACID

Robert Hall and Wilbert Chappell; *Madison College*

14. A brief description was given of the method used in preparation of anhydrous sodium acetate and anhydrous propionic acid. Solubilities were determined by the "synthetic or freezing point method." Results were in tabular and graphical forms showing the solubility concentrations in mole per cent of saturated solutions of sodium acetate in propionic acid over a considerable range of temperature. A description was given of the solvates isolated. A comparison of the system investigated and the system "Sodium Acetate-Acetic Acid" was noted.

THE GROWTH OF THIN FILMS OF γ -CuBr ON COPPER SINGLE CRYSTALS

Kenneth R. Lawless and Robert H. Kean; *University of Virginia*

15. Single crystals of copper were exposed at room temperature to a known vapor pressure of bromine and the reaction product was examined by electron diffraction and electron microscope techniques. The reaction product was γ -CuBr and was epitaxially oriented on the copper sub-

strate with apparent twinning of the bromide. Carbon replicas of the surface were examined in the electron microscope and showed the surface to consist of small facets. The relative rates of formation of the bromide film were different for different crystal faces, but the magnitude of the differences was apparently small.

ELECTRON MICROSCOPE STUDIES OF THIN NICKEL ELECTRODEPOSITS ON COPPER SINGLE CRYSTALS

Lucille B. Garmon; *Virginia Institute for Scientific Research*

16. Electrodeposited nickel films 100 to 1000 Å. in thickness were chemically stripped from the base metal and examined directly in the electron microscope. Twinning was observed on both (100)-oriented films and (111)-oriented films. Comparison between films of different orientations revealed that twinning was usually more extensive on (111)-oriented films. It was noted that the intersection of a twin with the crystal matrix was generally a region of weakness in the film.

THERMODYNAMICS OF AQUEOUS PHENOLS

W F. O'Hara and L. G. Hepler; *University of Virginia*

17. The quantity ΔH° at 25°C. for the ionization of aqueous meta chloro phenol was obtained by combining ΔH° ion of water with values for ΔH° of solution and neutralization of meta chloro phenol, obtained by using a high precision solution calorimeter. Combining this value of ΔH° ion with ΔF° ion, calculated from the literature value of the thermodynamic ionization constant, the value of ΔS° ion was calculated. These values were compared with the thermodynamic values for the ionization of other aqueous chloro phenols obtained in the laboratory. Similar investigations of other substituted phenols are being carried out.

STUDIES IN THE SYNTHESIS OF A SESQUITERPENE RING SYSTEM

Oscar R. Rodig and Norman J. Johnston; *University of Virginia*

18. A number of naturally-occurring sesquiterpenes, having the ring skeleton I, contain oxygen functions at position two and alkyl residues at position seven. Improved procedures have been developed for the preparation of various intermediates, including II, which can be used in the syntheses of these natural products.

1,6 Additions of various reagents to II provide one of the most facile routes for introducing functional groups at position seven. Studies on these adducts and their relationships to structures of naturally-occurring sesquiterpenes were presented.

SOME INDOLE DERIVATIVES RELATED TO NATURAL PRODUCTS

Walter H. Hartung and A. Garnett Richardson; *Medical College of Virginia*

19. Two analogs of reserpine and four analogs of ergonovine were reported in which tryptamine and certain other functional groups were retained, but the condensed ring structures were replaced by alkyl chains having a sufficient number of carbon atoms to conform to the same spacial patterns as the parent compounds. An indole derivative of nitrogen mustard, four derivatives of indole-2-carboxylic acid and three indole esters of 2-diethylaminoethanethiol were also reported. The latter have some potential as antiradiation drugs since the efficacy of the free thiol in this respect has already been established.

THE PREPARATION OF TRIALKYL PHOSPHOROTRITHIOITES AND THEIR COTTON DEFOLIANT ACTIVITY

Mathias F. Kelley and William R. Smithey, Jr.; *Virginia-Carolina Chemical Corporation*

20. The trialkyl phosphorotrithioites of a series showed interesting activity as cotton defoliants. Methods of preparation and the physical and chemical properties of the resulting esters were discussed. A preliminary correlation of defoliation activity with molecular structure was made.

BROMINATION REACTIONS OF 2-METHYL-2, 5-DIHYDROTHIOPHENE 1, 1-DIOXIDE AND SOME OF ITS SIMPLE DERIVATIVES

Robert C. Krug and James A. Rigney; *Virginia Polytechnic Institute*

21. Reactions were studied in which 2-methyl-2, 5-dihydrothiophene 1, 1-dioxide; its position isomer, 2-methyl-4, 5-dihydrothiophene 1, 1-dioxide; and the saturated cyclic sulfone, 2-methyltetrahydrothiophene 1, 1-dioxide were treated with bromine, N-bromoacetamide, N-bromosuccinimide or 1, 3-dibromo-5, 5-dimethylhydantion. Products were isolated which have been identified as 4-bromo-2-methyl-4, 5-dihydrothiophene 1, 1-dioxide and 3, 4-dibromo-2-methyltetrahydrothiophene 1, 1-dioxide. Another product has been assigned the structure of 2-bromo-2-methyl-2, 5-dihydrothiophene 1, 1-dioxide on the basis of its reactions and infrared spectrum.

PREPARATION OF SOME CYCLIC SULFONE DERIVATIVES BY THE HYDROBORATION REACTION

Robert C. Krug and Donald E. Boswell; *Virginia Polytechnic Institute*

22. Passage of excess diborane gas through a solution of 3-methyl-2, 5-dihydrothiophene-1, 1-dioxide (I) yields an organoboron compound analogous to a trialkyl borane. Alkaline oxidation of this material pro-

duces an alcohol tentatively identified as 4-hydroxy-3-methyl-tetrahydrothiophene-1, 1-dioxide (II). Acetylation of II yields the corresponding ester, acetoxy-3-methyl-tetrahydrothiophene-1, 1-dioxide (III), and reaction of II with thionyl chloride produces the corresponding halide, chloro-3-methyl-tetrahydrothiophene-1, 1-dioxide (IV). The physical constants and infrared spectra of II, III and IV were presented.

REACTIONS OF CIS- AND TRANS-DYPNONES

Landry T. Slade and Robert E. Lutz; *University of Virginia*

23. Cis-dypnones were prepared by irradiating solutions of transdypnones. Stereoisomeric epoxides were made. Trans-dypnone adds phenylmagnesium bromide largely 1,4, cis-dypnone, 1,2. Phenyllithium adds 1,2 to both stereoisomers, giving the same product, 1,1,3-triphenyl-1,4-butadiene. On heating, this gave 1,3-diphenyl-2,4-dihydronaphthalene, which was characterized by conversion to 1,3-diphenylnaphthalene. In evaluating configurational effects on reactivity of the beta-methyl, both stereoisomers were reacted with selenium dioxide giving 2,4-diphenylfuran and with N-bromosuccinimide giving trans-gamma-bromodypnone which resisted irradiation-inversion. Weakly basic morpholine converted trans-gamma-bromodypnone into trans-gamma-morpholinodypnone, but under refluxing into 2,4-diphenylfuran. Sodium acetate gave 2,4-diphenylfuran. Strongly basic sodium hydroxide and methoxide at -10° gave 1,2-dibenzoylthane, involving a novel rearrangement for which mechanism is postulated.

SYNTHESIS AND INVESTIGATION OF HYDRAZIDOOXALIC ACID

Thomas P. Foley, Jr., Thomas C. Imeson, II, David N. Keyes, and James K. Shillington; *Washington and Lee University*

24. Published methods for preparation of hydrazidooxalic acid proved to be unsatisfactory. Research was undertaken for its preparation along simple lines from inexpensive materials. Partial hydrolysis of diethyloxalate yields the ester salt. With hydrazine hydrate, the latter produces the salt of hydrazidooxalic acid. The free acid is obtained by acidification with the mineral acids. A study of the bifunctional nature of the free acid was made. The compound is a very strong acid with the hydraxido group overshadowed by the acid group. Electronically and geometrically, the nature of hydraxidooxalic acid is primarily monofunctional.

THE COUPLING OF GRIGNARD REAGENTS TO BENZYL SYSTEMS

Frank A. Vingiello, Sih-gwan Quo and John Sheridan;

Virginia Polytechnic Institute

25. In contrast to a report in the literature that phenylmagnesium bromide and benzyl chloride did not couple, an excellent yield of diphenylmethane was obtained in this reaction was extended to include various Grignard reagents and various substituted benzyl halides. The literature regarding this reaction was reviewed and the new findings presented.

AN UNUSUAL REDUCTION OBSERVED DURING THE COURSE OF A
GRIGNARD REACTION

Frank A. Vingiello and Thomas Delia; *Virginia Polytechnic Institute*

26. During a study of the synthesis of polynuclear aromatic hydrocarbons, 2-bromophenyl-1-naphthyl methane was required. The route chosen for the synthesis of this intermediate involved the reaction between 1-naphthylmagnesium bromide and 2-bromobenzaldehyde followed by the reduction of the hydrol. Quite unexpectedly, it was found that the Grignard reaction itself gave the reduction product 2-bromophenyl-1-naphthyl methane. This unusual reaction was investigated.

THE SYNTHESIS OF SOME NEW 10-SUBSTITUTED-ARYL 1,2-BENZANTHRA-
CENES

Frank A. Vingiello and Claude I. Lewis; *Virginia Polytechnic Institute*

27. In connection with research involving the synthesis of possible carcinolytic agents, two new complex 1,2-benzanthracenes were synthesized. The reaction paths leading to the successful syntheses of these compounds, namely, 10-(4-bromo-1-naphthyl)-1,2-benzanthracene and 10-(4-methyl-1-naphthyl)-1,2-benzanthracene were presented. A discussion of the syntheses of all new intermediates necessary for the preparation of these compounds was presented.

THE ZEEMAN EFFECT IN POLYATOMIC MOLECULES AND THE MAGNETIC
ROTATION SPECTRUMS OF NO₂

P. L. Goodfriend; *College of William and Mary*

28. Classes of electronic transitions which can yield strong Zeeman effects in polyatomic molecules are: (a) Transitions where both states are linear and $\Delta \Lambda \neq 0$; (b) Intercombinations; (c) Transitions between bent states and linear states with $\Lambda \neq 0$; (d) Transitions involving a state perturbed by a magnetic state or coupled to the nuclear framework. A strong magnetic rotation spectrum implies a strong Zeeman effect. The magnetic rotation spectrums of NO₂ at four field strengths were studied. Its extent, intensity predominance of 650 cm⁻¹ intervals and

its variation with field strength indicate a class (c) transition. Using theoretical considerations, $a^2\pi \leftarrow {}^2A_1$ transition was assigned to the visible system.

SECTION OF ENGINEERING

A MINIATURIZED GENERATING ELECTRIC FIELD METER

F. E. Moss, R. R. Humphris, B. J. Gilpin; *University of Virginia*

1. Electric fields emanating from aircraft, rockets and satellites have been measured both in this county and abroad. Recent studies of the electrical interactions between space vehicles and environments containing free charges, such as the ionosphere and the Van Allen Radiation Belts, have brought renewed interest in instrumentation capable of measuring surface electric fields and ion currents impinging on rockets and satellites. The electric field meter described herein consists of a small probe exposed to the field and ion current on the surface of the vehicle. This probe is alternately opened and closed by a motor-driven, grounded shutter so that the electric field and ion current impinging on the probe are chopped into a-c components. If a resistor be connected from the probe to the body of the vehicle, then voltage components proportional to the external field and ion current are generated across the resistor. The instantaneous generated voltage due to electric field is proportional to the time rate of change of probe area, while the voltage due to ion current is proportional only to exposed probe area. Thus, the field and ion current components may be separated by synchronous detection and are measured independently by the instrument.

AN A-C IONIZATION CHAMBER

W. P. Walker, R. R. Humphris and C. D. Broadbent;
University of Virginia

2. An ionization chamber using an alternating ion collection voltage (a-c chamber) was conceived for the use of an a-c system with high gain and narrow bandwidth. The average ionization current should be equal to the d-c ionization current of conventional chambers. However, results of an experimental chamber showed that at an average collection voltage less than the voltage required for complete ion collection during each half cycle, there was a large apparent increase in ionization current. A current amplification can be achieved by allowing some of the ions to remain in the chamber and oscillate with the collection voltage. This current or the amplification, is a linear function of the frequen-

cy, ion production rate, and area of the collecting electrode, but varies as the cube of the electric spacing. This study of the a-c chamber shows that it has great promise for the future and has the following advantages:

(1) Current amplification is obtained. (2) The time constant, or ion-concentration half-life, observed experimentally is approximately one-half second, and is very short when compared to conventional chambers. (3) A-c coupling may be used, thus eliminating stability and drift problems. (4) The a-c chamber is simple to zero-adjust, even in the presence of ionizing radiation. (5) Appreciable variations in a-c collection voltage may be experienced without significant change in signal level.

DESIGN OF A HIGH TEMPERATURE CONTINUOUS RUN ELECTRIC ARC WIND TUNNEL

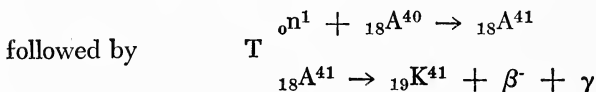
William Grossmann, Jr.; *Virginia Polytechnic Institute*

3. First results of an effort to produce high temperature gas flows with accurate scale flow simulation are presented. An electric arc wind tunnel, capable of producing stagnation temperatures up to 15,000 °R (at low pressures) was proposed and a full scale pilot model electric arc facility already completed was described. Theoretical calculations assuming air to be in equilibrium even at extreme temperatures were made in order to predict properties of the flow for varying stagnation conditions and results of this analysis are presented. Calibration of the electric arc facility was discussed, based upon the fact that atomic spectral lines tend to broaden out due to high temperatures and a definite shift in the position of the line of maximum intensity occurs resulting from mass motion of the gas. Description of intended future use of the electric arc wind tunnel included such topics as: (1) aerodynamic force tests in high speed dissociated gas flow, (2) magnetoaerodynamic studies, (3) qualitative studies of chemically reacting gas flows.

DETECTION OF RADIOACTIVE ARGON FROM THE UNIVERSITY OF VIRGINIA NUCLEAR REACTOR

J. K. Gilham; *University of Virginia*

4. Neutron irradiation of air inside reactor facilities produces radioactive argon by the (n,y) reaction:



with a half life of 112 minutes. This radioactive argon is discharged through tall chimneys, diluting the radioactivity in the atmosphere. Monitoring radioactive argon presents special problems since argon cannot

be filtered, adsorbed or absorbed. The radioactivity discharged in the atmosphere will be monitored by a Geiger tube suspended in the ventilation ducts leading to the chimney and will be constantly recorded on a quantitative Geiger counter scaler. Components for this system are readily available; thus providing a simple, inexpensive monitoring system. Radioactive argon once dispersed in the atmosphere is monitored by a low background beta counter using specially constructed planchets. This device will detect levels of radioactivity above one-tenth maximum permissible dosages. Attempts to measure dosages below this level have, to date, met with little success.

NUCLEAR DESIGN OF A THERMIONIC CONVERTER REACTOR

David J. Paul; *University of Virginia*

5. The Los Alamos Plasma Thermocouple consisted principally of a uranium carbide rod $\frac{1}{4}$ inch in diameter suspended in a stainless steel cylinder of 1 inch outer radius and $1/8$ inch walls. This device was lowered into a critical reactor whereupon fissions occurred in the uranium carbide and its temperature rose to 1500°C . The stainless steel walls of the cylinder were maintained at 300°C by convective cooling with oil. Conceivably an appropriate arrangement of such thermocouple tubes with a moderator-coolant flowing between them could form a nuclear reactor. This would produce d-c electricity free of heat exchanger and a-c generation equipment costs and have theoretical overall plant efficiencies of a phenomenal 40 per cent if the a-c and d-c production are both considered. A core of 4 ft. diameter and 4 ft. height would have the following power characteristics: Total fission power out—3 megawatts; Thermal power out—2.4 megawatts; A-C power out—0.6 megawatts; D-C power out—0.6 megawatts. The temperature of the steam going to the turbine was calculated to be 600°F and the temperature change across the core 43°F .

PERFORMANCE CHARACTERISTICS OF THE V. P. I. ARGONAUT RECTOR

E. Stam and A. Robeson; *Virginia Polytechnic Institute*

6. Since the V. P. I. Argonaut Reactor achieved first criticality in December 1959, a series of experiments has been underway to establish performance characteristics of the installation. A description of the reactor facility and results of some of the experiments are discussed. Critical mass, reactivity, control rod calibrations, power and shield performance characteristics are included.

A METHOD OF TRANSFORMING CONCENTRATED SURFACE FORCES INTO CONTINUOUS SURFACE FORCES

William Zuk and M. A. Majeed; *University of Virginia*

7. In such fields of mechanics as strength of materials, elasticity and vibrations, concentrated forces are often encountered. Because such concentrated forces represent mathematical discontinuities, the generalized analysis of such forces often presents difficulties. It is found that the use of Cauchy's Distribution Curve

$$\frac{P}{s\pi} \frac{1}{1 + \left(\frac{x-a}{s}\right)^2} \quad \text{as } s \rightarrow 0$$

to represent the concentrated force P lends itself well to simple analysis as the force may thus be treated as a continuous function in " x ." Several examples of beams with various end supports and load arrangements are described, giving the results for shears, moments, and deflections expressed in single closed form expressions, valid for any region of the beams.

ON THE MOTION OF A PARTICLE IN A FREE VORTEX CENTRIFUGE

John E. Scott, Jr.; *University of Virginia*

8. Consideration is given to the problem of classification of sub-sieve sized solid particles in a centrifuge in which a free vortex is maintained. The theory of operation of the centrifuge is discussed in terms of practical applications of the device. A non-ideal particle injection scheme, dictated by practical considerations, produces a deleterious effect on the performance of the classifier. Analysis of this effect leads to an ordinary, second-order, nonlinear differential equation, similar to the Fowler-Emden differential equation, which describes the radial motion of the particles in the centrifuge. Typical solutions of the differential equation, obtained from an analog computer, are presented; and the properties of the solutions are discussed.

THE ANALOG COMPUTER IN ENGINEERING ANALYSIS

J. P. Raney; *University of Virginia*

9. This paper deals briefly with a few practical applications of the electronic analog computer to engineering problems. The problems considered are: (1) The solution of the equation of motion of a particle in a free vortex centrifuge. (2) The effectiveness of a catalyst pellet in a second-order reaction. (3) The solution for forced transverse vibrations of a beam with all non-homogeneous boundary conditions when vibrating at frequencies well above the fundamental or first natural frequency of the beam. Problems 1 and 2 above are ordinary second-

order non-linear differential equations but require different techniques of solution; a trial and error solution is used on 2 while a direct solution is possible with 1. The solution to Problem 3 is finessed by knowing the general mathematical form of the solution at the outset which is in the form of normal modes of vibration and amplitudes of these normal modes. The beam is broken into three parts consisting of a long center section and two short end pieces to which the constraining springs and dampers are attached. By generation of the normal modes and then properly closing the computer loop on the equations of motion of the end pieces the solution is obtained.

AN ANALOG STUDY OF THE STABILITY OF FLEXIBLE MISSILES WITH
AUTOPILOT AND SECON-ORDER CONTROL RESPONSE

James B. Eades, Jr. and G. L. Smith; *Virginia Polytechnic Institute*

10. The flexibility of high-performance rocket vehicles is known to affect the stability of the system due to the bending, pitching, and control dynamics. Guidance and control systems respond to angular deflections in bending; and, under adverse conditions, structural feed-back into the control loop may lead to an instability. In this paper the structural feed-back problem is formulated in a simplified form, considering excitation of the structure in bending due to side control force. The governing differential equations for the system are derived; these lead to a sixth degree polynomial characteristic equation. To facilitate the study of this problem, the system is programmed on an analog computer with typical values of the variables assumed. In this manner a parametric study is conducted from which some simple relations are observed. An analysis of the results shows that the phase relations are of extreme importance in the stability of the bending modes. The computer results are applied to a typical missile; the variation of the different modes is plotted as a function of sensor location, all other factors assumed constant.

ON THE SIMULATION OF THE ELECTRON CONCENTRATION ENCOUNTERED
BY A BODY DURING RE-ENTRY TO THE EARTH'S ATMOSPHERE

John N. Perkins and A. J. Russo, Jr.; *Virginia Polytechnic Institute*

11. The purpose of this paper is to describe the idea of using a combustion yet as a means for producing a plasma stream with electrical properties similar to those encountered by a hypervelocity vehicle upon re-entering the earth's atmosphere. The problem of radio wave attenuation is described also since the combustion jet apparatus has particular application to the study of this phenomenon. The combustion jet uses cyanogen (C_2N_2 and oxygen (O_2) as reactants. The resulting

flame produces the highest chemically obtained temperature known to man (4,850 °K at atmospheric pressure). Potassium, an easily ionized material, is injected into the flame where it ionizes, and the resulting electron concentration is found to be large enough to simulate even the most extreme flight conditions encountered by a re-entry vehicle. Theoretical calculations of the electron concentrations behind the normal portion of the shock wave in actual flight are presented and are compared with the electron concentrations obtainable from the combustion jet laboratory apparatus.

PROPULSION SYSTEM REQUIREMENTS OF THE MANNED INTERPLANETARY VEHICLE

R. W. Truit and P. R. Kurzahls; *Virginia Polytechnic Institute*

12. The parameters influencing a vehicle trajectory in free space are used in a relatively simple analysis for deriving the equations of motion of a space vehicle. Cylindrical coordinates are used to define the vehicle and planet positions; and planetary orbits are represented by ellipses for which initial characteristics may be obtained from any ephemeris. Propulsion and radiation-pressure forces are expressed as functions of the initial inclination of the thrust vector to the flight path. These forces can be varied to allow an accurate simulation of impulsive or continuous propulsion systems during a specific flight. Gravitational forces for the sun and n planets are derived in terms of the radius vector between the vehicle and the attracting body, and the resulting equations of motion may be readily expanded to allow the inclusion of effects of planetary satellites, such as the moon. Because of the complexity of an n body problem of this type, an exact analytical solution is not feasible, and an IBM 650 Computer was used to solve the equations of motion by a fourth-order Runge-Kutta integration procedure.

SPACE CABIN REQUIREMENTS OF THE MANNED INTERPLANETARY VEHICLE

R. W. Truitt and P. R. Kurzahls; *Virginia Polytechnic Institute*

13. The requirements of a manned interplanetary vehicle are discussed, and the literature of space medicine and environment are summarized to isolate the physical parameters affecting man's survival in space. The basic requirements of manned space vehicles on prolonged trips are defined, and optimum solutions to some of the related problems are proposed. To illustrate typical values to be expected in later development, the preliminary characteristics of a space cabin suitable for a trip to Mars and return are then derived. A regenerative life support system capable of sustaining a crew of five for a thousand day journey is outlined, and a weight and volume breakdown of this system, along with

the auxiliary equipment required by such a space vehicle, is included. The final vehicle weight is compared with the weight of a similar vehicle carrying stored food, water, and oxygen.

A STUDY OF THE CONDITIONS WHICH CAUSE THE PITTING OF INCONEL AND INCOLOY DURING PICKLING

W. A. Wilkinson, J. A. Miller, and N. F. Murphy;
Virginia Polytechnic Institute

14. The pitting, while pickling, of Inconel and Incoloy was studied by varying the concentration of the pickling solution, temperature, and time of immersion. The concentrations of pickling solutions of nitric and hydrofluoric acid were varied from 29.06 and 5.66 to 35.87 and 3.41 weight per cent, respectively. Five chloride ion concentrations of 0 to 4.0 weight per cent were studied in each of the pickling concentrations. Specimen immersion times from 15 to 90 minutes and solution temperatures from 21° to 43°C were used. The investigation was designed statistically by using a fractional factorial with a one-fifth replication which permitted the study of second level interaction of the variables. The data were analyzed using an IBM 650 computer. The weight loss of Inconel and Incoloy increased with increasing hydrofluoric acid, chloride concentrations, time, and temperature. An interaction, chloride and temperature, was found to exist for Inconel. At lowest temperature weight loss decreases; at the highest temperature weight loss increases with increasing chloride concentration. No such interaction exists for Incoloy, but pitting increases with increasing chloride ion concentration.

A prediction equation relating the variables studied will be formulated.

NEUTRON FLUX MEASUREMENTS BY THIN GOLD FOILS

Arthur P. Deverill; *University of Virginia*

15. The induced beta activity in thin gold foils is used to measure neutron flux. Determination of the beta activity of the foil requires a knowledge of the following factors: foil's self-absorption; back scatter of the foil support; absorption in air (and window) of the detector; and, contributions from radiations other than betas resulting in the decay of the gold nucleus. Gold is evaporated onto plastic, irradiated in a Graphite Pile and counted in a 2π Low Background Detector. The above factors are optimized in the following manner: Foil self-absorption is minimized by using very thin gold films. The plastic substrate has negligible back scatter. The absorption in air is minimized by geometry, and absorption in window is low because of the thin mylar window of the detector. The contribution of gamma rays is minimized by the low efficiency of the detector to gamma radiation. The disintegration rate

of an activated gold film, which is proportional to the thermal neutron flux, can be determined from the observed activity.

NEUTRON FLUX MEASUREMENTS WITH A HYDRAULIC RABBIT

George H. Gardes and George A. Custer; *University of Virginia*

16. There are three reasons for determining the neutron flux in a swimming pool reactor: thermal flux is an indication of power level; flux levels are needed for irradiation experiments; fast flux indicates the amount of radioactive nitrogen in the water. A common method of measuring flux is with gold foils. The neutron flux in the University of Virginia Reactor will be measured by an aluminum slug system, driven by water pressure. The system is 22 feet long, allowing measurements to be made from the bridge across the pool. The system has 3/16" aluminum tubing in order to place the slugs between the fuel plates. The rabbit is the aluminum slug, and will be run both bare and Cd covered in order to obtain thermal and fast neutron flux. Aluminum has a low absorption cross section but the flux level will be high enough to secure an acceptable activity. After exposure in the core, the slug will be driven to the bridge and immediately counted for activity. The 2.3 minute half life activity will indicate the thermal flux level of the core at the measurement position. Many repetitions of this procedure will produce a flux plot of the core.

DESIGN FACTORS OF A NITROGEN ISOTOPE CHEMICAL EXCHANGE TOWER

C. A. Renfroe, D. A. Hayford and F. W. Bull; *Virginia Polytechnic Institute*

17. A study of the design aspects of a chemical exchange tower for the separation of nitrogen-15 and -14 was completed. The isotope exchange reaction proceeded by countercurrent contact of nitric acid and nitrogen oxides gas. An oxide reflux reactor was used to convert the nitric acid to nitrogen oxides by reaction with sulfur dioxide. A recovery tower was used to convert the nitrogen oxides to nitric acid by oxidation of the nitric oxide followed by absorption of the nitrogen dioxide in water. Verification of the third order mechanism for the oxidation of nitric oxide was affected. The effect of nitric acid strength in the reactor on the ratio of nitric oxide to nitrogen dioxide fed to the exchange tower was determined. Pressure drop data for the exchange tower were correlated with the chemical tests to yield operating limits of the exchange unit. Using an enrichment factor of 1.05 and the experimental operating limits, the following design criteria were evaluated: (1) the effect of retention time on the approach to steady state; (2) the effect of stage length on the approach to steady state; and (3) the interrelation of production rate, stage length and product composition at steady state.

HEAT TRANSFER AND PRESSURE DROP PERFORMANCE OF A BAFFLED HEAT EXCHANGER IN COOLING A PETROLEUM OIL

Fred W. Bull and Patrick H. DeHart, Jr.; *Virginia Polytechnic Institute*

18. This investigation was to study the effect of baffle design and spacing on the heat transfer and pressure-drop characteristics of a double-pipe, countercurrent heat exchanger in cooling a petroleum oil in stream-line flow. Visual flow studies were conducted on six disc baffles, one spiral wire baffle and one spiral strip baffle, the baffles being installed in a three-quarter inch diameter, pyrex glass pipe. A dye was injected into the oil stream 58 inches upstream from the battle, and the flow patterns around the baffle were observed visually and were photographed with a Speed Graphic camera using a shutter speed of 1/400 sec and a lens opening of f-4.7. Each baffle was evaluated by the length and width of disturbance imposed upon the oil stream. The spiral wire and spiral strip baffles exhibited the most effective visual performance, the disc baffles imposing no effective disturbance in the oil stream. Heat transfer and pressure-drop studies are now being conducted to evaluate the operational performance of each baffle.

ANOMALIES IN THE OPERATION OF OVEN-TYPE MOLECULAR BEAM SOURCES

Ricardo Zapata and John E. Scott, Jr.; *University of Virginia*

19. A discussion of the nature of flow in molecular beam sources is presented. Defining λ as the molecular mean free path in the source chamber and d as the diameter of the source orifice, free molecule flow is characterized by $\lambda \gg d$ and hydrodynamic flow by $\lambda \ll d$. For the case of molecular effusion the spatial distribution is given by the cosine law, and no intermolecular collisions occur. For the case of hydrodynamic flow, main motion is more pronounced in the axial direction than given by the cosine law, and the frequency of intermolecular collisions is relatively large. Experiments in both flow regimes are discussed. Results indicate that higher beam intensities are obtained by using a conical channel in the source chamber. Beam attenuation rates, due to collisions of beam molecules with background molecules in the collimating chamber, are also studied. It is found that the attenuation becomes significant when the collimating chamber pressure rises above 10^{-4} mm Hg. Total beam intensities of about 7×10^{13} molecules/sec have been obtained with nitrogen at room temperature. Improved pumping in the collimating chamber and optimum source design could increase this figure by an order of magnitude.

THE GENERATION OF MOLECULAR BEAMS FROM SHOCK TUBE SOURCES

Arthur C. Bruce; *Virginia Polytechnic Institute*

20. In the present day field of aerodynamics a problem of major interest is the simulation in the laboratory of high speed, high altitude vehicle flight. The present paper considers several aspects of generating a free molecule flow in the form of a molecular beam from a source consisting of a conventional shock tube. The results of performance calculations for a given shock tube utilizing a helium/air combination of driver/driven gases are presented in the form of ratios of pressure and temperature in the source to initial conditions before firing of the tube. The flow regime utilized in the tube for a beam source is that flow existing for a short duration at the end of the tube immediately after shock reflection from the tube end and previous to arrival of the contact surface at the tube end. It is shown that effusive flow requirements restrict the beam aperture size and beam intensity to a large extent, which combined with short steady source time necessitate a high sensitivity, fast response system of instrumentation.

NON-EQUILIBRIUM MOLECULAR DISSOCIATION OF AIR IN A HYPERSONIC NOZZLE

John N. Perkins; *Virginia Polytechnic Institute*

21. The equations of motion for the flow of dissociating air in non-equilibrium through a nearly conical nozzle have been developed. By treating the air as a mixture of two ideal dissociating gases, oxygen and nitrogen, the equilibrium solution is obtained. Assuming a simplified form of the rate equation, the equilibrium solution is extended to the case where equilibrium is not achieved everywhere in the flow. The results of the investigation suggest that deviations from dissociation equilibrium will occur in the nozzle, but that the so-called phenomenon of "freezing" will not occur as generally predicted for single diatomic gases.

AN OPTIMIZATION STUDY ON LOW THRUST ROCKET PARAMETERS

James B. Eades, Jr.; *Virginia Polytechnic Institute*

22. A study on the influence of several design parameters for low thrust rockets is carried out to ascertain the relation between these parameters for optimal considerations. Due to the dependency of these parameters on one another, a simplified analysis is set forth which shows the influence of a programmed trajectory on the final weight, velocity gain and payload. For a maximum payload, the influence of the optimal path thrust and/or power on payload is defined. In addition the attained velocity and the exhaust velocity are described for a specified average of the optimum conditions.

ON A SOLUTION TO THE UNSTEADY LAMINAR BOUNDARY LAYER

H. A. Hassan; *Virginia Polytechnic Institute*

23. It is shown that the transformation $\xi = x/\sqrt{2 \nu t}$, $\eta = y/\sqrt{2 \nu t}$ reduces the unsteady laminar boundary layer equations in two dimensions to an equation in which "t" does not appear explicitly provided that the free stream velocity $V(x, t)$ can be expressed as $(\sqrt{\nu/2 t}) h(\xi)$. A power series solution is assumed for the resulting equation, and it is

shown that for $h = \sum_{n=0}^{\infty} a_n \xi^n$ (α an integer) the solution can be

expressed in terms of universal functions. For all values of α , the zeroth term of the assumed series, which is chosen to satisfy the outer boundary condition exactly, is governed by known equations.

QUANTUM MECHANICAL ASPECTS OF THE THERMODYNAMIC PROPERTIES OF GASES

Robert W. Truitt; *Virginia Polytechnic Institute*

24. The chemical equilibrium composition of a hydrogen plasma is determined over the temperature range from 10^3 °K to 10^6 °K and pressures from 10^{-6} to 1 atmospheres. The solution of the equations is simplified by considering the problem in two steps: the first in the temperature range where dissociation occurs and the second in which only ionization occurs. The general method of attack is outlined which is applicable to the equilibrium solution of any plasma. Particular attention is given to the formulation of the partition functions and to the quantum mechanical aspects of the thermodynamic properties of the plasma. Equilibrium and frozen values of the ratio of specific heats and the speed of sound are presented in the complete dissociation and ionization regimes. Some interesting thermodynamic property changes that occur during dissociation and ionization are discussed relative to application to high-speed aerodynamic analysis.

AN ENGINEERING STUDY OF A ROTARY DRUM CRYSTALLIZER

John C. Chaty; *University of Virginia*

25. The rotary drum crystallizer is a purification device which incorporates the principles of zone melting and conventional fractional crystallization for the recovery of organic or inorganic solute of high purity from the solvent. In the rotary drum crystallizer, solids are deposited from the molten liquid on the cooled surface of a drum, are carried from the melt by rotation of the drum, and then removed and conveyed

to another crystallization stage. While this crystallization device is not a true zone refiner which involves the traveling of a small molten zone through a long solid charge with redistribution of the solute in the charge, neither is it a conventional fractional crystallizer where solids are formed and removed as fine crystals. It is believed that this device has great advantages in heat and mass-transfer effectiveness and in ease of mechanical separation. In a single stage laboratory scale rotary drum crystallizer the process variables, such as, the temperature difference between the melt and the drum surface, the rate of drum rotation, and the depth of immersion are studied. Preliminary results show that from a melt of 95% naphthalene-5% benzoic acid a product of 99.5% naphthalene is obtained under favorable conditions.

THE DETERMINATION OF HEAT TRANSFER CHARACTERISTICS FOR A MOVING BED SYSTEM COMPOSED OF AIR AND ACTIVATED CARBON

W. A. Barkley and Stuart B. Row; *Virginia Polytechnic Institute*....

26. Heat transfer characteristics for moving particles of carbon in an air atmosphere were studied. A single pass, co-current heat exchanger 36 inches long was constructed using 3/4-inch and 2 1/2-inch schedule 40 black iron pipe as the tube and shell, respectively. Steam was used as the heating medium. Three variables, steam pressure, carbon flow rate, and carbon particle size, were evaluated in the investigation. Steam pressure was varied from 15 to 75 psig, at 15 psig increments; carbon flow rate was varied from 2.2 to 11.0 lb/hr, at 2.2 lb/hr increments; and carbon meshes of 10, 14, 20, 28 and fines were tested. Thirty tests were made to approximate the results of a complete evaluation (125 tests). An equation relating the overall heat transfer coefficient with the three variables has not yet been completed, but the following trends for the overall heat transfer coefficient, U indicated: (1) U increased as the carbon flow rate increased; (2) U increased as the carbon particle size increased; and (3) U remained approximately constant with changes in steam pressure. Calculated values for U varied from 1.58 to 4.02 Btu/hr-ft.²-°F. A straight line temperature profile through the heat exchanger indicated a varying carbon film coefficient.

THE USE OF HIGH ROTATIONAL SPEED EQUIPMENT TO COMPLEMENT MOLECULAR BEAM STUDIES IN GAS DYNAMICS

Hubert J. Davis, Jr.; *University of Virginia*

27. The production of molecular beams at the University of Virginia Research Laboratory for the Engineering Sciences has made it desirable to design and construct a device to experimentally determine the distribution of velocities in molecular beams. The currently accepted method of

accomplishing this purpose is by use of a device consisting of a rigid shaft separating two circular discs. Around the periphery of the discs are cut narrow radial slots. With proper design, this particular configuration, when placed in a molecular beam, will allow molecules only within a small velocity range to pass through the selector. Analysis shows that a device of entirely different configuration should produce the same results. This latter type of selector consists of a thin circular ring in which narrow slots are cut in a direction perpendicular to the radii of the ring. The ring selector has the inherent advantage of being readily adaptable to techniques of magnetic suspension. However, a detailed analysis shows that even with careful selection of design parameters, structural limitations prohibit a ring selector design consistent with the performance necessary for use in molecular beam studies.

THE ANALYSIS OF ION BEAMS USING A RADIO FREQUENCY MASS SPECTROMETER

Hugh S. Landes; *University of Virginia*

28. An r-f mass spectrometer for analyzing low energy ion beams was built. The unit is a miniature modification of a design by Paul, et. al. It employs the mass dependence of a strong-focusing electric quadrupole field for the filtering of different masses. A spectrometer operating on this principle is a pure mass filter in the sense that neither energy selection nor momentum selection is required; ions are selected solely on the basis of mass. The field structure, measuring 8 cm in diameter by 26 cm in length, is portable and can be placed in a vacuum system. The apparatus is capable of measuring ions of mass numbers ranging from 1 to 140 with a resolution up to 150. The spectrometer has been used successfully to analyze a molecular beam of nitrogen ions for impurity content. Intensities as low as 1 part in 1000 were measured. In addition to the determination of beam purity content, the spectrometer will be used to identify particles before and after collisions. The small size and convenience of handling, coupled with ability to select a particular mass, regardless of energy, makes the r-f spectrometer a valuable device in the research of low energy molecular beams.

HIGH SPEED DRAG ON ROTATING CYLINDERS AT LOW PRESSURES

J. H. Bodine; *University of Virginia*

29. Consider a gas between two infinitely long concentric cylinders of radius a and b ($b > a$), the inner cylinder rotating with a peripheral velocity V . Assume the density of the gas sufficiently low so that a negligible number of molecular collisions occur in the annular space, the

molecules moving from surface to surface in straight lines. Also assume the gas molecules leave each surface with a Maxwellian distribution of velocities with respect to a coordinate system fixed onto that surface corresponding to a common temperature. The velocity distribution in a non-rotating coordinate system of the molecules leaving the inner cylinder will be skewed by rotation, resulting in the pressure in the annular region being a vector quantity. Define $Q \equiv a/b$, S as the ratio of V to the most probably velocity of the molecules leaving the surface, and p_y as the pressure measured perpendicular to a radius at the outer cylinder surface. A detailed analysis shows the torque per unit length will be:

$$a \sqrt{x} p_y a^2 s / G(Q, S)$$

The function $G(Q, S)$ will be defined and numerical values of it presented. Generally: (1) $G(Q, S) \geq 1$; (2) $G(Q, S)$ is monotonically increasing in S ; (3) $G(Q, S)$ is a maximum for a Q of about 0.65.

A TECHNIQUE FOR MEASURING CAPACITY CHANGES OF TWO INSULATED HEMISPHERES

B. J. Gilpin and R. R. Humphris; *University of Virginia*

30. In this paper, the total capacity between two insulated hemispheres is considered as being composed of a direct capacity and a mutual capacity. The direct capacity is defined as the "free space" capacity between the two hemispheres. The mutual capacity is defined as the series combination of the two capacities between each hemisphere and ground. An experimental technique is described for determining the variations in the total and the component capacities as a function of: (1) the distance above a conducting grounded plane; (2) the diameter of the sphere, and (3) the separation of the hemispheres. A size factor is determined so that the results of measurements made on specific spheres may be extended to other sizes. The changes in the total capacity which occurred between the two halves of the sphere as they approached ground were detected by a neon tube oscillator built into the sphere in such a manner that the total capacity between the hemispheres was one of the frequency-determining components of the circuit. The neon tube was mounted in a flashlight reflector, and a Fresnel lens was used to focus the light onto a phototube. The output of the phototube was amplified and the frequency determined by a Hewlett-Packard, Model 524B, electronic counter.

A PROXIMITY PICKUP WITH A VACUUM TIGHT PROBE

W. M. Bland and W. H. Dancy, Jr.; *University of Virginia*

31. Displacement measurements of metallic objects which are vibrating at high speeds are possible using a non-contacting probe and read-out

system. A tuned grid-tuned plate r-f oscillator coupled to an infinite impedance detector was used in the system. Any voltmeter, oscilloscope, or recorder may be used to read-out the displacement. The grid coil of the oscillator was physically separated from the remainder of the circuit and was connected electrically through coaxial cable. This grid coil acted as a proximity pickup due to the loading effect produced when metallic objects were placed in the r-f field produced by it. To facilitate measurements in both pressure and vacuum environments, the grid coil was mounted on the end of a sylphon bellows sealed, micrometer slide apparatus which may be inserted into the environmental chamber through a standard "veeco" vacuum seal. The micrometer slide permitted calibration and adjustments in position, while the apparatus was operating. By operating the oscillator at a frequency of 6 mc, one obtained an output signal of 2 volts per 0.001" of displacement, linear over ± 15 thousandths of an inch. This output signal followed displacements which occur at rates up to 100 kc.

PREPARATION OF PLATED SPECIMENS FOR MICROSCOPIC EXAMINATION OF CHROME-STEEL INTERFACE

J. B. Fracis and W. H. Dancy, Jr.; *University of Virginia*

32. A method of polishing was developed which permitted a highly magnified examination of the interface of chrome plated steel specimens. The specimen was prepared by grinding on a series of emery papers of decreasing grit size. It was polished for two minutes on a polishing table covered with "Fisher No. 12-284" polishing cloth, using "Gam-al" (gamma alumina) as polishing compound. The sample was then gently polished on a No. 0000 emery polishing paper for two minutes. The alternate grinding and polishing operations were repeated at least three times. The specimen was then etched for 20 seconds in a 50% by volume solution of hydrochloric acid and water maintained at room temperature. Since chromium is etched at a higher rate than steel, this treatment leaves the surface of the chromium lower than that of the steel. Final polishing removed the excess steel and leaves the chromium surface highly polished and level with the steel. A final 15 second etch in a solution of ethyl alcohol containing one drop of concentrated nitric acid per cc darkened the steel surface and gave sufficient contrast between chromium and steel to allow detailed boundary examination at high magnifications.

SATELLITE ORIENTATION USING MAGNETIC SUPPORT METHODS

R. E. Russell and O. R. Harris; *University of Virginia*

33. The usefulness of an earth satellite as an experimental device would

be greatly enhanced if it could be spatially oriented in a controllable manner while in orbit. Three flywheels mounted orthogonally within the satellite and rotated by electric motors should provide the desired attitude control of the satellite. However, the frictional loss in angular momentum of the fly-wheels will result in undesired rotations of the satellite. One method of eliminating the mechanical bearing friction is the electromagnetic support technique developed by J. S. Beams of the University of Virginia. The proposed system consists of a three-dimensionally supported ferrite or sphere and a drive system to rotate the sphere in the desired direction. Preliminary calculations were made assuming what was considered to be a "worst case" orientation problem. For a ferrite sphere with a rotational hysteresis loss constant of 150 dyne-cm/cm³, the sphere radius was found to be about 10 cm. and the required peak driving power is 122 watts. Additional work is now being done on the use of conducting spheres; estimates are being made of the torque interaction between the support field and the rotating sphere.

THE SOAKING EFFECT — APPARENT DRAG REDUCTION ON BODIES HELD AT LOW PRESSURES FOR EXTENDED PERIODS OF TIME

J. E. May and A. R. Kuhlthau; *University of Virginia*

34. In using a concentric cylinder apparatus for the determination of drag in gases at low pressures it was observed that drag apparently decreases when the apparatus is allowed to stand at low pressures for several days. This has been called the soaking effect. In the present experiments the effect was studied over a month wider range of variables than heretofore. The results of this study, are not yet conclusive, but suggestions for further rather crucial experiments were obtained.

A STRENGTH CRITERION FOR COMPACTED FINE-GRAINED SOILS

H. G. Larew; *University of Virginia*

35. Two strength criteria for the failure of compacted fine-grained soils under the action of repeated loads were postulated and experiments to investigate these were initiated on three soils: a micaceous silt, a limestone residual clay, and a sand-clay. Conventional and repeated stress triaxial strength tests were employed to study and compare the strength and deformation characteristics of identical specimens of each soil which had been carefully prepared by a static compaction process. For the soils studied and the test conditons employed, a criterion of failure has been established as follows: a critical level of repeated deviator stress exists at which the slope of the curve of deformation versus number of repetitions is constant after the first few load applications. For levels of deviator stress in excess of this critical value, the deformation curves

eventually turn concave upward, their slopes increase and the soil fails either in shear or by excessive deformation. For levels of deviator stress less than the critical value, the deformation curves eventually approach a horizontal asymptote.

ROTATIONAL HYSTERESIS LOSSES IN NICKEL-ZINC FERRITES AT LOW FREQUENCIES

R. Berner and H. S. Landes; *University of Virginia*

36. Measurement of rotational hysteresis losses of small ferrite spheres at low frequencies were made. Rotational hysteresis torque arises from an interaction between the magnetization and the crystal structure, but very little is actually known about the interaction mechanism involved. It is known, however, that since there is a coupling between magnetization and crystal structure, a rotation of the magnetization in the body will produce a torque on the body itself. It would appear that this effect might be useful in torquing a magnetically supported rotor. For this, ferrite compositions of high torque densities might be used, or the ferrites could be used as rotors for a magnetically supported free gyroscope, in which case, a reduction of rotational loss is of interest. Ferrites belong to a group of non-conducting magnetic materials with low or high rotational losses depending primarily on composition. A torsional pendulum apparatus was used for the measurements. A clear trend toward zero rotational hysteresis losses was obtained in a group of nickel-zinc ferrites by varying composition.

MAGNETOSTRICTION IN Ni - Zn FERRITES

G. S. Nurre and H. S. Landes; *University of Virginia*

37. As part of a ferrite research program, a device for measuring magnetostriction was built and measurements were taken for several ferrites. Since the magnetostriction coefficient (λ) for these ferrites is of the order of 10^{-6} cm/em, for a one cm diameter sphere, dimensional changes of 10^{-6} cm must be measured. An ultramicrometer, consisting of a differential capacitor, was designed with satisfactory sensitivity. The device was calibrated by measuring the calculated deflection of a small doubly supported steel beam, and was found to be linear with a sensitivity of 3.73×10^{-6} em per millivolt. Measurements were made of λ as a function of applied field for a series of Ni - Zn ferrite and for a Co - Zn ferrite. The magnetostriction curves are compared to the magnetization curves, and the comparison is especially interesting for the Co - Zn ferrite, which exhibits a change of sign in the magnetostriction curve. For the ferrite series, $\text{Ni}_\gamma \text{Zn}_{1-\gamma} \text{Fe}_{1.95}$, λ_s is plotted as a function of γ . The data indicate that λ_s is linearly dependent on γ and is zero for $\gamma = .225$. The

position of the zero point is as expected, since the Curie temperature for $N_{0.225}Zn_{0.775}Fe_{1.95}$ is very close to room temperature.

SECTION OF GEOLOGY

MINERAL PARAGENESIS IN THE MYERS-L. COPENHAVER BARITE MINES SMYTH COUNTY, VIRGINIA

Donald K. Grubbs and Robert C. Barnes; *University of Virginia*

1. This paper is concerned with the Myers-L. Copenhaver mines, which are situated four miles west of Marion, in Smyth County, Virginia. Its two-fold purpose is to report a new occurrence of sphalerite in Virginia, and to interpret the sequence of mineral deposition at the deposit in which it occurs. The barite and gangue minerals occur as fracture fillings within brecciated Beekmantown limestone of Ordovician age. The fractures are irregular in pattern and are filled with hydrothermal minerals which were deposited at very low temperatures — as evidenced by the complete lack of alteration in the wall rock. The minerals in the general order of deposition are pyrite, sphalerite, limited purple fluorite, barite, clear fluorite, and calcite. The pyrite occurs in thin, fine-grained bands lying adjacent to the wall rock in most cases. Honey colored sphalerite generally follows the pyrite. A small amount of deep purple fluorite appeared to have been deposited before the barite crystallized. The next mineral in the sequence is the radiating, tabular, or prismatic barite. Clear fluorite follows it, and is usually succeeded by white calcite. Considerable overlapping occurred, particularly among the last three minerals.

RETENTION OF KCl BY HALLOYSITE

G. W. Thomas; *Virginia Polytechnic Institute*

2. The retention of KCl by hydrated and dehydrated halloysite was studied, using clays from Floyd and from Piney River, Virginia. Washing solutions used were 95 percent ethanol, 100 percent methanol and distilled water. Ethanol removed KCl ineffectively from hydrated halloysite. About eight washings were required with methanol to remove the bulk of the salts, while water cleaned the hydrated clay rather completely in three washings. Dehydrated clays were washed effectively by both methanol and water while ethanol was somewhat less effective. X-ray data showed that the KCl was held between layers of hydrated halloysite, suggesting that drying before KCl-saturating destroyed the salt-holding site.

COMMENTS ON APATITE FROM THE MOREFIELD MINE, AMELIA COUNTY VIRGINIA

E. H. McGavock and R. S. Mitchell; *University of Virginia*

3. Apatite grains and crystals, ranging from less than 1 mm to over 5 mm across occur in cleavelandite and quartz at Morefield Mine, Amelia County, Virginia. The material is light gray, white or pale aqua-green in color, with stubby crystals consisting of pinacoids and first and second order hexagonal prisms. Goniometric studies showed the presence of 11 forms on one crystal. Indistinct cleavage occurs parallel to $(10\bar{1}0)$ and (0001) . X-ray powder data compare favorably with typical fluorapatite patterns. The apatite fluoresces a bright orange-yellow in both long- and short-wave ultraviolet radiation. In unfiltered copper x-rays, the mineral fluoresces a bright yellow. No phosphorescence was observed as a result of ultraviolet radiation, but x-rays produced a persistent yellow phosphorescence. Strong orange-yellow thermoluminescence occurs when the apatite is heated in a Bunsen burner flame in the dark. Most apatite is not fluorescent. A semiquantitative spectrographic analysis was made to determine impurity elements which might activate the fluorescence. Trace elements (oxides) made up about 7% of the mineral's composition, of which, about 1% was rare-earths (chiefly cerium and yttrium), 2.5% silicon, and 2% manganese. Manganese produces a bright yellow fluorescence in some phosphates. Comparison of Morefield apatite analyses with published analyses of rare-earth apatites from Mineville, N. Y., showed that the chief difference was the high manganese content in the Morefield material. The Mineville apatite is not fluorescent, thus it seems that the activating element is manganese.

GEOLOGY OF THE LEXINGTON QUADRANGLE, VIRGINIA

Kenneth F. Bick; *Washington and Lee University*

4. The Lexington quadrangle, Virginia, includes parts of the Blue Ridge and the Valley and Ridge province of the Appalachian Highlands. The range in age from Precambrian to Middle Devonian. The Precambrian igneous and metamorphic basement complex is unconformably overlain by 2500 feet of clastic and volcanic rocks of Precambrian and Early Cambrian age. These rocks represent westward transgression of a sea across the area. The clastic rocks are overlain by 10,000 feet of Early Cambrian to Middle Ordovician rocks, chiefly carbonates, that represent a long period of shallow water, offshore deposition. The carbonate sequence is overlain by about 5000 feet of Middle Ordovician to Middle Devonian clastic rocks that represent the debris eroded from land areas east of the quadrangle. The rocks were deformed during the Appalachian orogeny. There are 3 structural units: the Blue Ridge, the

Central, and the Northwestern belts. The Blue Ridge belt is characterized by folding and faulting of the Precambrian basement complex; it is bounded on the northwest by the previously unmapped South River fault. The Central belt is characterized by low angle thrust faulting of the sedimentary rocks. The Pulaski fault branches southwest of Fairfield and the west (main) branch is continuous with the Staunton fault. The minor east branch, earlier considered to be the main Pulaski fault, is named the Fairfield fault. A complex area near Brownsburg is a window in the North Mountain fault and this fault is also complicated by three branches northwest of Brownsburg. The center branch is the main fault. The Northwestern belt is characterized by folding of the sedimentary rocks. One thrust fault of minor displacement bounds a large overturned anticline in the northern part of the belt. The deformation appears to proceed from folding of sedimentary rocks to thrust faulting of sedimentary rocks and finally to thrust faulting of the competent basement complex over the other structures. (*Published by permission of the State Geologist, Virginia Division of Mineral Resources.)

A DIABASE DIKE NEAR GREENVILLE, AUGUSTA COUNTY, VIRGINIA

Frank Howard Campbell, III and John Milton Cole, Jr.;
University of Virginia

5. A diabase dike ranging in width from 35 to 50 feet was traced from Avis to the C. T. Glover farm on Virginia Secondary highway 695, 0.8 mile south of Arbor Hill, for a total length of 5.5 miles. This intrusive crosses U. S. 11 approximately 3.3 miles north of Greenville, southern Augusta County, Virginia. The dike transects strata ranging from the upper Cambrian Elbrook dolomite to the upper Ordovician Martinsburg shale. The dike which trends from N 10 W to N 25 W crosses the Massanutten syncline near its southwestern terminus. Roughly 0.1 mile east of the confluence of Virginia Secondary 697 with 693 the dike crosses the Staunton Fault. According to T. L. Watson and R. W. Johnson, Jr. this and many other dikes in the region closely parallel a known major joint direction of the Appalachians. Thus we conclude that the emplacement of this intrusion was joint-controlled. Microscopically, this olivine diabase contains abundant calcic labradorite, twinned according to the albite and carlsbad laws. Considerable augite surrounds the plagioclase to form a well-developed ophitic texture. Olivine is third in importance and an estimated 3 to 4 per cent is present. Although aeromagnetic surveys by the U. S. G. S. have found that the diabases of the Valley show little or no magnetic expression, the calculated susceptibility of the rock is 10,200 cgs units. The extent and attitude of the dike was studied with a Schmidt balance vertical force magnetometer. Six traverses were run normal to the dike trend. These magnetic profiles having a maximum expression of

600 gammas. It is postulated that other diabases of the Valley will give good expression to ground magnetic survey methods.

A PETROGRAPHIC STUDY OF SOME DIKES IN A QUARRY IN BLUEGRASS VALLEY, HIGHLAND COUNTY, VIRGINIA

E. K. Rader and V. S. Griffin; *University of Virginia*

6. The dikes under consideration were found in a quarry 2.5 miles north of the village of Hightown, Highland County, Virginia. One basic dike and four intermediate dikes were observed. An abundance of serpentine was noted in the basalt, possibly due to the post crystallization migration of the hydrothermal residual solutions of the andesite magma. The intermediate dikes have previously been classified as "felsophyre" and "granite-feldsophyre," but our petrographic work revealed that the name andesite porphyry would better describe this light-gray dike material, composed of plagioclase (basic oligoclase to acid andesine), biotite, hornblende, ilmenite, limonite, hematite, and leucoxene. These dikes appear to be controlled by jointing and two low to moderate angle reverse faults, which have caused brecciation giving rise to the carbonate pebbles in some of the andesite materials. It appears that the folding of the Hightown anticline and the jointing occurred first. Next, the basalt was injected into a NW trending joint in the Beckmantown limestone. Finally, the andesite was intruded along both joints and faults trending NE.

UNDERGRADUATE RESEARCH PARTICIPATION PROGRAM IN VPI DEPARTMENT OF GEOLOGICAL SCIENCES

Byron N. Cooper; *Virginia Polytechnic Institute*

7. The undergraduate research participation program carried on during the last six weeks of the summer of 1959 and during the fall and winter quarters of the 1959-60 academic year was sponsored by the National Science Foundation. Eight undergraduates were selected for the program, and each participant was assigned a limited research project. The six weeks during the summer, when field work was carried on, allowed time for gathering of field data. During the fall and winter months, the participants worked up their data, carried on laboratory studies, and drafted final reports on their studies. The results are being presented before the Virginia Academy of Science in order to show that it is not only possible but quite feasible to launch students into limited research participation while they are still undergraduates. The studies, and drafted final reports on their studies. The results are knowledge of the geology of Virginia. Three of the studies uncovered types of field evidence that are of special and outstanding significance

to our understanding of the geology of the Appalachian Mountains. Considering the funds invested and the tangible accomplishments of the program, as indicated by the following papers, the undergraduate research participation program was very successful.

STRATIGRAPHY AND PETROGRAPHY OF TWO SECTIONS OF NOLICHUCKY SHALE IN THE SOUTHWEST PART OF VIRGINIA

James W. Bryan; *Virginia Polytechnic Institute*

8. Two of the finest exposed sections of the Upper Cambrian Nolichucky shale are situated in Russell and Smyth Counties, Virginia. The unique lithology can be subdivided into three distinctive parts: an upper part consisting of banded limestones, dolomites, and fossiliferous calcarenites; a central part consisting of calcareous shales, dolomitic sandstones, and edgewise conglomerates with limestone and dolomite pebbles and a lower part consisting of banded limestones and dolomites. The Nolichucky is largely limestones and dolomites in Virginia and the usage of Nolichucky "shale" is somewhat misleading. Two hundred samples collected during the detailed litho-stratigraphic measurements were subjected to controlled acid tests and 90 were examined by x-ray studies. The yellowish-brown, sandy textured weathering or rusty weathering, characteristics of the Maynardville lithology, proved to have a varied mineralogy and were not indicative of dolomite as has generally been considered. Some sample of the rusty weathered material proved to be pure calcite. The megascopic appearance of the different beds can not always be correlated directly with the mineralogy of the beds. A potassic feldspar occurs with the carbonates as well as the other clastic beds.

POST-CANADIAN DISCONFORMITY AND THE RELATED MOSHEIM LIMESTONE NEAR CHATHAM HILL, VIRGINIA

Wilson Fisher, Jr.; *Virginia Polytechnic Institute*

9. The post-Canadian disconformity and the overlying Mosheim limestone were mapped in detail in three areas near Chatham Hill, Smyth County, Virginia. The maximum relief of the surface of disconformity in the mapped areas is 160 feet, but "stray" detrital pieces of Knox chert in overlying beds as high as the Effna formation suggest that the local relief may have been as much as 400 feet. Vertical cliffs and overhangs in the Knox group are evident along the disconformity. The Mosheim limestone consists of a series of lenses which are thickest in old stream or river channels on the disconformity. The lenses of Mosheim limestone thin out against topographic "highs" of the erosional surface and some debris from these "highs" was transported into the lower

areas during deposition of the overlying Lenoir limestone. The basal part of the Mosheim consists of coarse clastic limestone containing interbedded chert breccias and dolomite conglomerates, with some detrital dolomite. The clastic rocks follow the disconformable surface and were deposited at different times in pockets of the Knox dolomite, as the basal portion of the Mosheim limestone. Numerous "veins" of relatively fine grained clastic material transect the bedding of the Mosheim and are composed of dolomitic sand and chert fragments from the Knox. These "veins" are generally at right angles to bedding and fill clefts or cavities left by fracturing and solution of the Mosheim immediately after consolidation.

AREAL GEOLOGY OF THE REGION JUST SOUTH OF SALTVILLE, VIRGINIA

Joel T. Blankenship; *Virginia Polytechnic Institute*

10. The abrupt southeastward deflection in the trace of the Saltville fault in the vicinity of Saltville, Smyth County, Virginia, poses an interesting problem: Is the deflection in the fault trace the consequence of a cross or tear fault that offsets the Saltville thrust, or is the offset merely the consequence of local flattening of the thrust surface, which causes the trace to follow a level-line course around the hills that rim Saltville on the east and south? Areal geologic mapping of the formations southeast of the fault trace of the Saltville thrust shows no offset of any mappable units comprising the thrust block. The swing in outcrop pattern of the various mappable units in the Upper Cambrian and Lower Ordovician formations in the south and east environs of Saltville does not require any cross faulting, and none apparently exists. This interpretation means that immediately east of Saltville, the thrust surface is flat over a considerable area, which might make drift mining of salt a feasible undertaking.

CHEMICAL STRATIGRAPHY OF MIDDLE ORDOVICIAN LIMESTONES IN A PORTION OF RICH VALLEY, SMYTH COUNTY, VIRGINIA

Edward L. Lee; *Virginia Polytechnic Institute*

11. The Effna limestone, which immediately underlies the Middle Ordovician black graptolitic shales in a portion of Rich Valley southwest of Porterfield Quarry and Worthy Mine, is a high-calcium limestone that varies considerably in thickness. The maximum thickness is about 175 feet and the formation thins to the southwest and finally pinches out entirely. The limestone is a typical calcarenite and constitutes a great bank of shell sand containing little magnesium carbonate and relatively little insolubles. The thickness of the limestone and chemical analyses obtained from channel samples taken from excellent outcrops provide a

basis for estimating the limestone reserves in a belt about 4 miles long. Locally the stone is sufficiently thick and pure to be minable just as it is at Portefield Quarry and Worthy Mine, operated by Olin Mathieson Chemical Corp.

STRATIGRAPHY AND BRACHIOPOD FAUNA OF THE CHATHAM HILL LIMESTONE AT THE TYPE LOCALITY

Donald E. Hallinger; *Virginia Polytechnic Institute*

12. The lithology and fauna of the Chatham Hill limestone have never been completely described at the type locality in Smyth County, Virginia. Two detailed stratigraphic sections in the Chatham hill limestone were measured, one at the type locality 3.0 miles south of Chatham Hill, and the second approximately 5 miles north along strike at a point 2.5 miles southwest of Nebo, Virginia. Many well preserved brachiopods were obtained by dissolving limestone samples from a number of zones in the Chatham Hill limestone. Among them are *Sowerbyella perplexa*, *Dinorthis transversa*, and *Opikina dorsatiformis* which were not previously reported at the type locality. In addition, large numbers of specimens were obtained which provide additional information on the morphology and stratigraphic and geographic range of species previously described by G. A. Cooper from nearby areas.

STRATIGRAPHY AND PLEONTOLOGY OF THE "MAYSVILLE" DIVISION OF THE MARTINSBURG SHALE FORMATION NEAR CHATHAM HILL, SMYTH COUNTY, VIRGINIA

R. L. Sutherland; *Virginia Polytechnic Institute*

13. The Maysville division of the Martinsburg, characterized by the well-known brachiopod, *Orthorhynchula stevensoni*, constitutes one of the best known stratigraphic zones in the Paleozoic succession of the Appalachian Valley region. The major purpose of the writer's study was to determine whether the various well-known fossils in the *Orthorhynchula* zone constitute one faunule or several definite faunules. The characteristic lithology of the zone is a calcareous siltstone, some layers of which are characteristically concretionary. This type of lithology is gradational with the cross-laminated sandstones of the overlying Juniata. The fossil pelecypods and inarticulate brachiopod, *Lingula nicklesi*, seem to occur together in many places. *Orthorhynchula* is common in various beds throughout the zone that bears its name. *Lingula nicklesi* is more characteristic of the upper part of the zone which averages about 85 feet thick, but it also occurs in the lower part of the division. The Maysville clams are very characteristic of a zone about 10 feet below the top of the Maysville division.

SECTION OF PSYCHOLOGY

CERTAIN TIME RELATIONS IN SERIAL ROTE LEARNING

Gene Wilson and Rosemary Hartman; *The College of William and Mary*

1. To determine why the serial position curve is skewed, Deese and Kresse employed 4-sec. and unpaced rate of nonsense syllable presentation. The present study repeats these conditions and adds an 8-sec. rate. Both obtained typical serial position curves. Remote associations were symmetrically distributed about the center of the list. The curve of failures-to-respond in the Deese and Kresse study was skewed under the paced condition and reached an asymptote near the middle of the list for the unpaced condition. The present study found bowed curves for all rates of presentation although this effect was least pronounced under the unpaced condition. Rate of presentation appeared to have had its greatest effect on failures-to-respond.

INDIVIDUAL DIFFERENCES IN BINARY PATTERN RECOGNITION

Dorothy W. Dyer and E. Rae Harcum; *The College of William and Mary*

2. Right-left field differences in accuracy of reproducing tachistoscopically exposed binary patterns were investigated. Observer's eye dominance and cerebral hemisphere dominance were simulated, respectively, by monocular viewing and by different element contrasts in opposite hemi-fields. Relatively greater accuracy occurred for elements having greater contrast. Group results indicated greater accuracy left of fixation, and no effect of viewing eye. However, of the twelve observers the four who exhibited nearly equal binocular performance for the two hemi-fields also exhibited superiority of the nasal retinae with monocular viewing. A learned bias favoring left elements apparently can overcome viewing eye effects.

ATTENSITY GRADIENTS IN THE PERCEPTION OF BINARY PATTERNS

David Camp; *The College of William and Mary*

3. Three experiments were performed investigating binocular perception of ten-element binary patterns tachistoscopically exposed to the right or left of fixation. Experiment I, using blackened and open circular elements, yielded minimal errors of reproduction adjacent to fixation, maximal errors at the sixth position, and a relative minimum at the extremes. There were no right-left differences. In Experiments II and III an attempt was made to flatten the error curves by adjusting target

size and brightness respectively as a direct function of the errors made in Experiment I. In both cases there was an increase in errors in the foveal region with no significant peripheral effect.

A FURTHER EXPERIMENT CONCERNING DEPENDENCY CONTRAST IN VISUAL DEFLECTION AND RECOGNITION

E. Rae Harcum; *The College of William and Mary*

4. The surface microstructures in eight target forms were the same as or different from background surfaces. For a given surface, a unit of microstructure was black or white depending upon whether it was different from the brightness of the adjacent preceding unit in an arbitrary sequence. Dependencies of 100%, 75%, and 50% produced three different surfaces. Generally, a greater difference between target-surface microstructure and background microstructure produces more frequent target detections. Stimulus characteristics determining recognition of target form are also discussed. The results from these 26 observers corroborate those reported earlier for two observers tested under somewhat different conditions.

THE ACQUISITION OF PROBABILISTIC PAIRED ASSOCIATES AS A FUNCTION $S-R_1 : S-R_2$ RATIO AND BLANK TRIALS

James H. Woods; *University of Virginia*

5. Previous studies of probabilistic paired associates, in which two response syllables are learned to each stimulus syllable, have shown that response frequency is an increasing function of stimulus probability. This study compared the influence of increasing numbers of blank trials (trials on which neither response member occurred) within the above framework. The results indicated that frequency of response for the more frequently occurring response syllable decreased as blank trials increased. However, the less frequent response was not affected by different numbers of blank trials.

SOME EFFECTS OF LONG-CONTINUED, LOW-INTENSITY, GAMMA IRRADIATION ON THE RAT

Leonard E. Jarrard; *Washington and Lee University*

6. Rats were continuously exposed for 60 days to a low-intensity source of cobalt 60. One group of 24 animals received 539 r., another group received 230 r., and an additional 24 served as nonirradiation controls. Body weight and food consumption were recorded throughout the irradiation period. Half of the animals began training in a water

maze after 7 days while the other half started training 37 days after irradiation. Results indicated that for these conditions, a small amount of continuous irradiation affected body weight but not learning, whereas a greater amount was accompanied by a decrement in learning but no further loss in body weight.

AN EXPERIMENTAL INVESTIGATION OF FORGETTING AND ANXIETY

John H. Borghi; *The College of William and Mary*

7. A repression-like inhibition was observed for associate responses when followed by a raucous buzzer. Subjects were asked to respond to one-hundred Kent-Rosanoff words and were buzzed when they gave certain critical responses. The initial instructions suggested to the subject that these buzzed responses were "poor." Following the administration of a Taylor Anxiety Scale, the subjects were asked to recall all one-hundred responses. There was less recall of the buzzed words, indicating some support for the hypothesis of repression.

CONDITIONS DETERMINING SHORT-TERM RETENTION IN SEQUENTIAL TASKS

H. R. Brackett; *University of Virginia*

8. Three experimental conditions were employed to test the effect of interference when the members of natural classes of items do not occur together but are mixed among different arbitrary categories which shift in their makeup from presentation to presentation. Condition I afforded opportunity for grouping but offered a minimum of inter-items interference. Condition II prevented grouping and provided opportunity for interference. Condition III prevented grouping but minimized interference. It was predicted that recall scores would be best under Condition I, next best under Condition II, and worst under Condition III. These hypotheses were borne out by the results of the experiment.

WORK AS A MEASURE OF MOTIVATION IN OPERANT CONDITIONING

Nelson F. Smith; *The College of William and Mary*

9. A progressively increasing work load was required of animals under different periods of food deprivation. White rats pressed a lever in a Skinner box to operate a mechanical food vender. Rats were tested under four periods of deprivation; 0, 24, 48, 72 hours. The work load was varied by progressively increasing the weight on the lever. It is thought that the maximum load undertaken by the rat might be used as a measure of the motivation induced by food deprivation, since the data thus far indicate a linear relationship between work load and hours of deprivation.

A BAR PRESS APPARATUS SUITABLE FOR CONSTRUCTION AND USE BY STUDENTS

Peter Guthrie and David Camp; *The College of William and Mary*

10. An undergraduac laboratory for studying animal behavior was provided with bar pressing apparatus by having the members of the class construct their own equipment from pre-cut aluminum sheets, bars and angles. The class, working in pairs, constructed this equipment during the first two three-hour lab periods of the semester at a cost of about \$3.50 per box. This apparatus has proved reliable in the demonstration of magazine training, operant conditioning, extinction, spontaneous recovery, discrimination learning and the effects of several schedules of reinforcement. The project appears to have had heuristic value for the students involved.

DISTRIBUTION OF PRACTICE IN CONCEPT FORMATION

James Crouse; *College of William and Mary*

11. Does massed practice facilitate the learning of concepts? Some evidence in the literature suggests that it may if certain conditions are met, in spite of the well-known principle that it hinders rote learning. This experiment required Ss to discover a concept, i.e., the consonants k, p, r, t, embedded in some of the groups of a list of 180 pairs of groups of eight consonants presented by a modified memory drum. Two groups of 24 college students practiced without a rest or with 45 seconds rest after every ten stimulus presentations, with an eight-second inter-stimulus interval held constant. The results indicated that learning was significantly faster by massed practice.

THE SECONDARY REINFORCING VALUE OF LOW INTENSITY SHOCK

Douglas K. Candland and James F. Campbell; *University of Virginia*

12. Research based on reinforcement theory has tended to separate stimuli into categories, such as positive and negative, or appetitive and aversive. Such distinctions have obscured the possibility that a stimulus may assume different properties depending upon its effect on the organism during previous training. To test the possibility that a negative stimulus could become positive, this study used electric shock in a bar-press situation to determine whether the shock would assume positive properties as a secondary reinforcer. Rats were trained to press for food reinforcement with a constant current a.c. shock accompanying each bar-press. All rats were then extinguished, so that food no longer accompanied a bar press. Half of the animals received shock with each bar press, while the other half did not receive shock. Both

groups responded the same number of times during a two-hour extinction period. The group which still received shock during extinction pressed at a slower, but more consistent, rate than did the group for which shock was eliminated during extinction. It was concluded that shock may come to serve as a positive reinforcer with training.

THE EVOKED ELECTROCORTICAL RESPONSE AND ITS RELATION TO BEHAVIORAL CONDITIONING

George M. Gerken; *University of Virginia* and
William D. Neff; *University of Chicago*

13. Bipolar electrodes were implanted in auditory cortex of six cats. After the cats recovered from surgery, the potentials evoked from auditory cortex by acoustic stimuli were recorded with an EEG machine over a period of 18 to 21 daily sessions. During these sessions, the animals were restrained in a conditioning apparatus that permitted leg flexion responses. All animals received either six or nine preconditioning sessions which were followed by sessions in which classical conditioning, avoidance conditioning, and pseudo-conditioning training procedures were used. A session by session analysis of the EEG records showed that a variety of changes took place in the evoked potential during the preconditioning period and during conditioning. These changes did not present a consistent pattern from cat to cat.

INTERACTION OF HUNGER AND ESTRUS IN THE RAT

Robert L. Rhyne; *University of Virginia*

14. Twenty-two hour food deprivation in the mature female rat produced relatively greater changes in wheel activity during the anestrus than during estrus. The character of running behavior was differentially altered depending on whether the animal was restricted or free to run during the daily feeding. Concurrent measures of food consumption, water intake, and body weight showed no consistent relationships to either amount of activity or to the hormonal state as determined by daily vaginal smears. Recovery periods showed essentially normal running patterns with a reinstatement of inverse relationships between ingestional and body weight changes, and the estrous activity cycle.

DISCRIMINATION REACTION TIME TO A VIBROTACTILE DISPLAY

Raymond C. Bice, Jr.; *University of Virginia*

15. As a part of a program studying the problems associated with tracking to vibratory stimulus displays, a vibratory discrimination reaction time test has been devised. The directional stimuli are presented

by four skin vibrators mounted in a rubberized vest in such a way that the stimuli are delivered to the chest. Subjects learn to react correctly and rapidly to the display, but there is greater difficulty when the response panel is horizontal (at right angles to the display) than when it is vertical (parallel to the display) because of disturbances in the body image. Subjects tend to regard stimuli delivered to the upper part of the chest as nearer than those delivered low on the chest.

ELECTRICAL STIMULATION OF THE SKIN — ON PURPOSE

Robert H. Gibson; *University of Virginia*

16. Pain is readily produced by electric stimuli. This is fortunate for research on pain, but limits the usefulness of electric signals for tactual communication. The present report is part of an investigation to find conditions for painless electric stimulation. Previous findings were that painless stimulation with alternating current was possible on only certain areas of the body, other areas responding with pain. It is now found that the latter areas will also yield painless sensations when stimulated by certain temporal arrangements of brief, biphasic electrical pulses.

THE SCALING OF MOTOR NOISES IN TERMS OF ANNOYANCE

James Harvey Brown; *University of Virginia*

17. Ten motor noises were recorded on tape and equated for loudness. Groups of subjects scaled these noises in terms of annoyance by the method of successive intervals and the method of paired comparisons. Spectrograms were made of each noise. Within and between scale analyses were made in terms of position on the scale, significant differences between the scale values, and the spectrograms. Six of the original ten noises formed a final scale, the utility of which lies in its potential use for determining the annoyance values of other motor noises.

THE DEVELOPMENT OF AFFECTIONAL RESPONSES IN INFANT DOGS

George J. Igel; *University of Virginia* and Allen D. Calvin; *Hollins College*

18. Dr. Harry Harlow has shown that, for monkeys, "contact comfort" is a more important variable than lactation in the development of the affectional bond between infant and mother. The present study was undertaken to (1) investigate the development of the affectional bond in a species other than the monkey, namely the dog, and (2) to investigate further the effect of lactation on the development of the affectional responses. Sixteen mongrel puppies served as subjects. The results of the present study show that dogs also prefer cloth mother to wire mothers under all conditions of feeding, but that lactation is a

variable of significant importance when paired with cloth mothers, but that lactation is not a significant variable when paired with the wire mothers.

TESTING IN JUVENILE COURT: (SURVEY

Ray Naar; *Richmond, Virginia*

19. The importance of environmental factors upon a Subject's performance has often been recognized. It was felt that the performance of juvenile delinquents would be particularly affected by the fact that these children had come within the purview of the law. To determine whether this belief was shared by other psychologists working under similar circumstances, as well as what steps were taken to neutralize or account for such factors, a questionnaire was mailed to a number of juvenile courts throughout the country. The answers to the questionnaire were tabulated and discussed.

NEED AFFILIATION: APPROACH AND AVOIDANT ASPECTS

Richard N. Carrera; *V.A. Hospital, Richmond, Virginia*

20. The French "Test of Insight" was employed to investigate the correlates of need affiliation, which may be defined as a need to be with and be liked by other people. Findings indicate that there are two general types of need affiliation, which may be designated positive and negative on the basis of underlying motivation. Positive need affiliation is a genuine liking for other people, which results from a history of satisfying relationships with others. It is positively correlated with personal popularity and may be regarded as a personality asset. Negative need affiliation is defensive in quality and is based on a chronic fear of rejection. This trait tends to be negatively correlated with effectiveness in interpersonal functioning.

MENTAL HOSPITAL ADMISSION RATES AS A MEASURE OF THE EXTENT OF MENTAL ILLNESS IN MODERN AMERICAN SOCIETY

Henry B. Adams; *V.A. Hospital, Richmond*

21. Admissions to mental hospitals have multiplied in recent decades. Is there an increase of incidence of mental illness in modern society? Analysis of hospital admission figures raises doubts about such an interpretation. Rates of admission vary widely from state to state. Almost all this variation can be explained by (1) the number of hospital beds available and (2) the rate at which deaths and discharges make space for new admissions. Differences in urbanization, income, and proportions of the aged in the population have only limited effects on admis-

sion rates. These rates are often influenced by many factors unrelated to the incidence of mental illness, and there is no conclusive evidence that any true increase has taken place.

INTELLIGENCE AND LOGICAL REASONING ABILITY

Fred McCoy; *University of Richmond*

23. Whether logical reasoning ability may be considered primarily learned or innate has shown conflicting evidence. Present work shows a close relationship between intelligence and logical reasoning ability.

TWO VALIDITY STUDIES OF THE WIDE RANGE ACHIEVEMENT READING TEST

Rudolph F. Wagner and Fred McCoy; *Richmond Public Schools*

24. The Wide Range Achievement Test, reading section, is appealing in its simplicity and interview-type administration, but is generally rejected by experts because it is unorthodox and unsupported by research. In independent studies, Wagner and the Clinic staff found the WRAT to correlate beyond the .01 level with several validation criteria, and when the two studies were compared, to have striking similarity in results. Results of the two studies tend to support the validity of the test.

SECTION OF STATISTICS

COMPOUND BINOMIAL DISTRIBUTIONS AND TARGET THEORY

Malcolm E. Turner; *Medical College of Virginia*

1. The probabilistic theory of hits by quantum particles upon microscopic targets has had wide application in biological research. These applications include problems in the inactivation of viruses by radiation and discernment of the number of quanta required to produce a visual image. The theory as developed by Timofeev-Ressouvsy and Zimmer is reviewed and certain extensions, variations, and modifications are suggested in light of certain compound distributions of the unknown parameters.

SEQUENTIAL ALLOCATION OF PATIENTS IN CLINICAL TRIALS

Robert J. Taylor; *Virginia Polytechnic Institute*

2. A scheme for conducting clinical trials that allows the proportion of patients assigned to the various treatments to be changed at specified times during the course of the trial depending on the results up to that

time is discussed. The proportion of patients assigned at each stage is determined by use of a "weighting function." Several weighting functions are presented along with the results of sampling experiments using random numbers to simulate actual clinical trials. These results are compared to the situation with equal proportions of patients on all treatments discussed by Sobel and Huyett.

ON THE COMBINATION OF ERRORS IN AGRICULTURAL RESEARCH

N. R. Thompson; *Virginia Polytechnic Institute*

3. Some agricultural investigations involve one or more stages of sampling, followed by chemical analyses and experimental trials. Also, certain biological "constants," derived from previous observations, may enter into the calculations. The results from such investigations, if used to make inferences applicable to whole populations, should be evaluated with respect to all sources of error. Linear combinations of the individual errors may be appropriate. Some errors may be much larger, and therefore of more importance, than others. Also, when variances of the "constants" are included, the total error may increase.

THE MEASUREMENT OF RISK IN AGRICULTURAL PRODUCTION

Paul H. Hocpner; *Department of Agricultural Economics, V.P.I.*

4. This discussion deals with the statistical techniques used to measure the risk involved in certain phases of agricultural production. The primary tool used was the two-way analysis of variance model with the data classified by years and farmers. After certain necessary adjustments in the data, variance components are computed from the mean square terms to estimate the variance associated with years, farmers and random error. Both year and random error variances constitute risk. Finally, the discussion deals with the estimation of the variance of a sum, difference, product and quotient, to indicate the procedures used to combine the numerous variance estimates into a single measure of risk (variance of net income).

THE RELIABILITY AND COST CONSIDERATIONS OF SYSTEMS WITH SPARE COMPONENTS

Donald F. Morrison; *National Institute of Mental Health and Virginia Polytechnic Institute*

5. A *system* is said to consist of n components, not necessarily of the same kind, whose lives are independent random variables specified by some known probability distribution. Failure of any component will cause the entire system to fail. In addition to the original components,

a set of k spare elements is available for replacing successive failures within the system, until the $(k + 1)$ th failure, when the system ceases operation. The distribution of system life has been determined for a general component life density $f(x)$, and expected total life has been evaluated for certain gamma-type densities. System *reliability*, or the probability that the final failure will not occur prior to some time T , has been tabled for certain of these densities. Since total life is not the only measure of the advantage of including spare components with a system, the distribution of the number of element failures on a given time interval has been investigated. From the expected number of failures on the interval, expected total life, and system reliability, a cost function for determining the optimum number of spares is proposed. Systems with different types of components present a more complex statistical problem. Such devices have been studied for exponential component lives with a different failure rate for each type. Expressions for expected system life have been obtained, and tables for allocating spares to different component groups for maximum expected system life or reliability have been constructed.

SOME TESTS FOR OUTLIERS

C. P. Quesenberry and H. A. David; *Virginia Polytechnic Institute*

6. This paper will propose a test statistic which is the extreme deviate from the sample mean divided by a pooled estimate of the standard deviation. The components of the pooled estimate consist of the estimate from the sample and an independent estimate. This statistic is appropriate for a one-sided test. The modulus of the above statistic is proposed for the two-sided test. Some tables of percentage points will be given for both of these statistics for the 1 and 5 per cent levels.

A SOYBEAN EXPERIMENT INTERPRETED WITH RESPECT TO GENETIC MODELS

Theodore W. Horner, Booz, Allen Applied Research, Inc., and
Charles R. Weber; *Iowa State University*

7. Estimates of genotype components and environmental variances were obtained as functions of thirty covariances and variances computed on data involving the F2 through F7 generations of a soybean cross. The estimated genotype and environmental variances were then used to estimate gains from selection. These were then compared to observed gains from selection and found to agree closely with respect to some characters and poorly with respect to others.

A STUDY OF SOLDIER PREFERENCES FOR VARIOUS BLENDS OF ROASTED AND GROUND COFFEES IN THREE STRENGTHS

Elie Weeks; *Quartermaster Research and Engineering, Fort Lee, Virginia*

8. During the fall of 1959 the Food and Containers Engineering Branch, Quartermaster Research and Engineering Field Evaluation Agency conducted a test of four blends of roasted and ground coffee and one type of instant coffee. Each blend or type was prepared and served in three strengths to some 720 soldiers stationed at Fort Lee, Virginia. Each soldier tasted and rated four coffees. The design of test was a partially balanced incomplete block design, in which each of the 15 "coffees" was served to an equal number of men in each of the four serving orders at each of the eight test sessions. This design provided 960 ratings for each of the three coffee strength levels, and 576 ratings of each of the five blends or types of coffee. Ratings were obtained on a 9-point hedonic scale ranging from "Like Extremely" to "Dislike Extremely."

CONTRIBUTIONS TO THE METHOD OF PAIRED COMPARISONS

H. A. David; *Virginia Polytechnic Institute*

9. The method of paired comparisons is widely used in sensory difference testing whenever judgments have to be of a subjective nature. It has been applied to taste testing, color comparisons, personnel rating, and generally to all forms of preference testing. In the present paper a new approach both to the execution and the analysis of paired-comparison experiments is discussed. This approach is based on the analogy between these experiments and popular methods of organizing competitions, such as Round Robin and Knock-out tournaments.

SOME ASYMPTOTIC RESULTS IN A BALANCED PAIRED-COMPARISON EXPERIMENT

B. J. Trawinski; *Virginia Polytechnic Institute*

10. In a balanced paired comparison experiment involving t treatments, T_1, T_2, \dots, T_t , subject to sensory judgment, each treatment is compared with all the remaining treatments once in every replication. The number of replications n is determined in such a way that the best treatment is declared as such with a preassigned probability P . It is assumed that there is no difference between the judges or the n replications. The assumption in the model is that the best treatment is better than the second best by a specified probability of preference

$$\pi = \frac{1}{2} + \Delta, \quad 0 < \Delta < \frac{1}{2},$$

and the probability of preference for any comparison between the treatments excluding the best is $\pi = 1/2$; this situation is usually referred

to as the least favorable configuration. With the above model and asymptotic distribution theory a table has been prepared giving the number of replications necessary for the detection of the best treatment with specified probability P . The entries n are functions of π , t , and P .

METEOROLOGICAL APPLICATIONS OF POWER-SPECTRUM ANALYSIS

R. E. Walpole; *Roanoke College*

11. The applications of power-spectrum analysis to meteorological data are discussed in general and then illustrated specifically by obtaining a power-spectrum analysis of horizontal wind speed on data collected from a 200 foot steel tower at the White Sands Missile Range. The results are compared with similar analysis made at Brookhaven National Laboratory and Oak Ridge. The data was collected in a dry desert-type climate from a flat countryside bordered by two mountain ranges approximately one hundred miles apart. The method of analysis is given and the results are discussed. The direction for further investigation is suggested along with the difficulties that arise.

MULTIVARIATE ANALYSIS OF INCOMPLETE-VARIABLES DESIGNS

Irene Monahan; *Virginia Polytechnic Institute*

12. Methods of estimation and tests of hypotheses are developed for multivariate experiments in which a different subset of the p variables under study is observed in each of k groups of n sampling units. The matrix of observations in the i th group is $Y_i' = X_i' M_i$ where M_i is a matrix of ones and zeros which selects from X_i' ($n \times p$) the u variables measured. An explicit expression for the maximum likelihood estimate of the parameter matrix and an equation involving that of the dispersion matrix are obtained by differentiating the likelihood function for the whole sample of kn observations. The latter equation is solved by the Newton iterative method.

SOME CONTRIBUTIONS TO THE EVALUATION OF PEARSONIAN DISTRIBUTION FUNCTIONS

John White; *Virginia Polytechnic Institute*

13. This paper represents a report of the construction of extended tables of percentage points of the Pearson Distributions. It consists of two parts: (1) The evaluation of the cumulative distribution function of the Pearson system (except for the so-called Type IV distribution) for a given pair of parameters β_1 and β_2 ; and (2) The determination of percentage points associated with a given probability level. The tables

presented here have been extended, both in accuracy and as well as increasing the ranges of β_1 and β_2 . Numerical illustrations are presented showing the closeness of the Pearson approximation with the exact distribution.

THE PREDICTION OF COLLEGE SUCCESS FROM TESTS AND HIGH SCHOOL ACHIEVEMENT

John M. Long; *The College of William and Mary in Norfolk*

14. The predictive data used were scores on entrance tests and high school records for a group of freshmen at the College of William and Mary in Norfolk. The criterion of the study was College quality point average. Standard multiple regression analysis techniques were used. Considered in this paper are: (1) High school quality point average was used. Eleven other academic ability and achievement measures were used. Ten personality scales and ten interest indices were also used. (2) Thirty-two predictor variables were used. The inter-dependence of most of the variables resulted in a spreading out effect which obscured many otherwise significant variables. Smaller groups of one, two and five were selected. The results compared favorably with that for all thirty-two variables. (3) Computations were performed on an I.B.M. 650 Data Processing System. The smaller groups were selected using the Wherry-Doolittle Test Selection Method and using variables with highest simple correlations with the criterion. Certain implications for prediction of a complex criterion are discussed. For such studies the size of the sample needs to be quite large. The value of using such a large number of interdependent variables is doubtful.

OPTIMUM ALLOCATION IN REGRESSION SPLIT-PLOT EXPERIMENTS

R. M. DeBaun; *American Cyanamid Company* and
Victor Chew; *U. S. Naval Weapons Laboratory*

15. In the literature, experimental designs for regression analysis are usually optimized with respect to the total number of observations to be taken; also, in the optimization, the cost of taking an observation is assumed to be the same for all treatment combinations. In this paper, cost functions are introduced and optimum designs are derived for both extrapolation and interpolation, including split-plot situations where the cost of taking an additional sub-plot observation is small relative to that of a main plot.

CONDITIONAL DISTRIBUTIONS ARISING FROM VARIATION OF PARAMETERS
IN A NON-LINEAR RESPONSE FUNCTIONMax H. Myers and David C. Hurst; *Virginia Polytechnic Institute*

16. This paper proposes that the growth of an individual organism follows a mathematical model closely and that different individuals follow different members of the same parametric family of models. This implies that the variation observed between individuals measured at the same time arises not from an additive term as has been previously supposed, but primarily from variation of the parameters of the model. A graph of data from an experiment on chickens is included which points up this individuality and the increased variation resulting from the passage of time. The three models considered were growth curves employing two, three, and four parameters, respectively, with biological interpretations existing for the parameters. The parameters were allowed to follow independent uniform distributions and independent gamma distributions.

GROUP TESTING IN BINOMIAL AND MULTINOMIAL SITUATIONS

Rolf E. Bargmann and Frederick L. Carter; *Virginia Polytechnic Institute*

17. This is a study and extension of methods of finding defective members in a population by testing groups of an optimum size. For the case where the over-all population size is finite, strategies by Sobel and Groll, and Sterrett were discussed. Properties and extensions of the Dorfman technique were considered. This is the situation where the population may be infinite or unspecified. A somewhat related problem concerns the detection of error in iterative procedures, where cumbersome checks have to be made at certain intervals.

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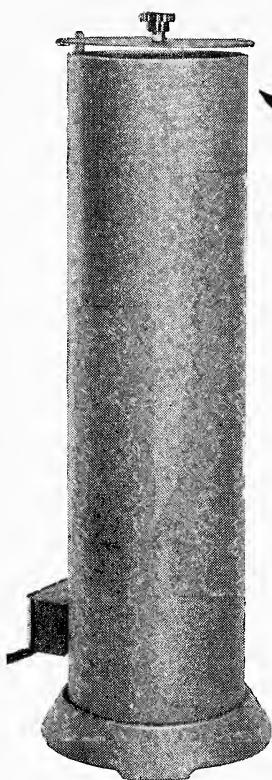
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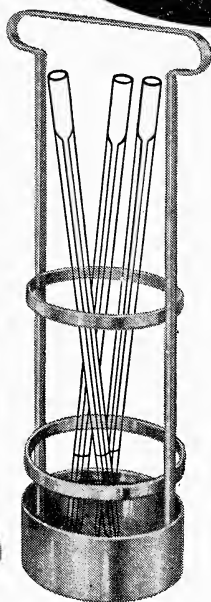
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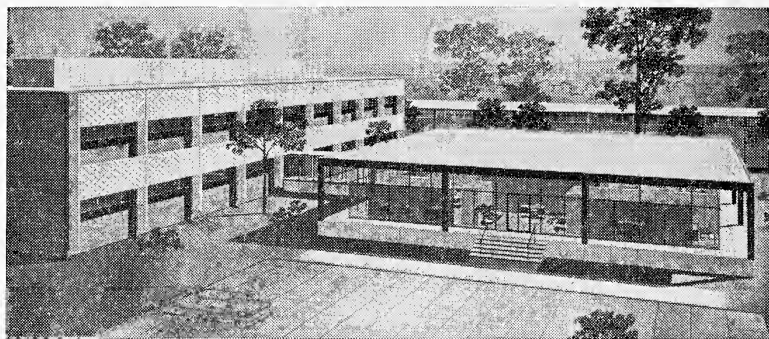
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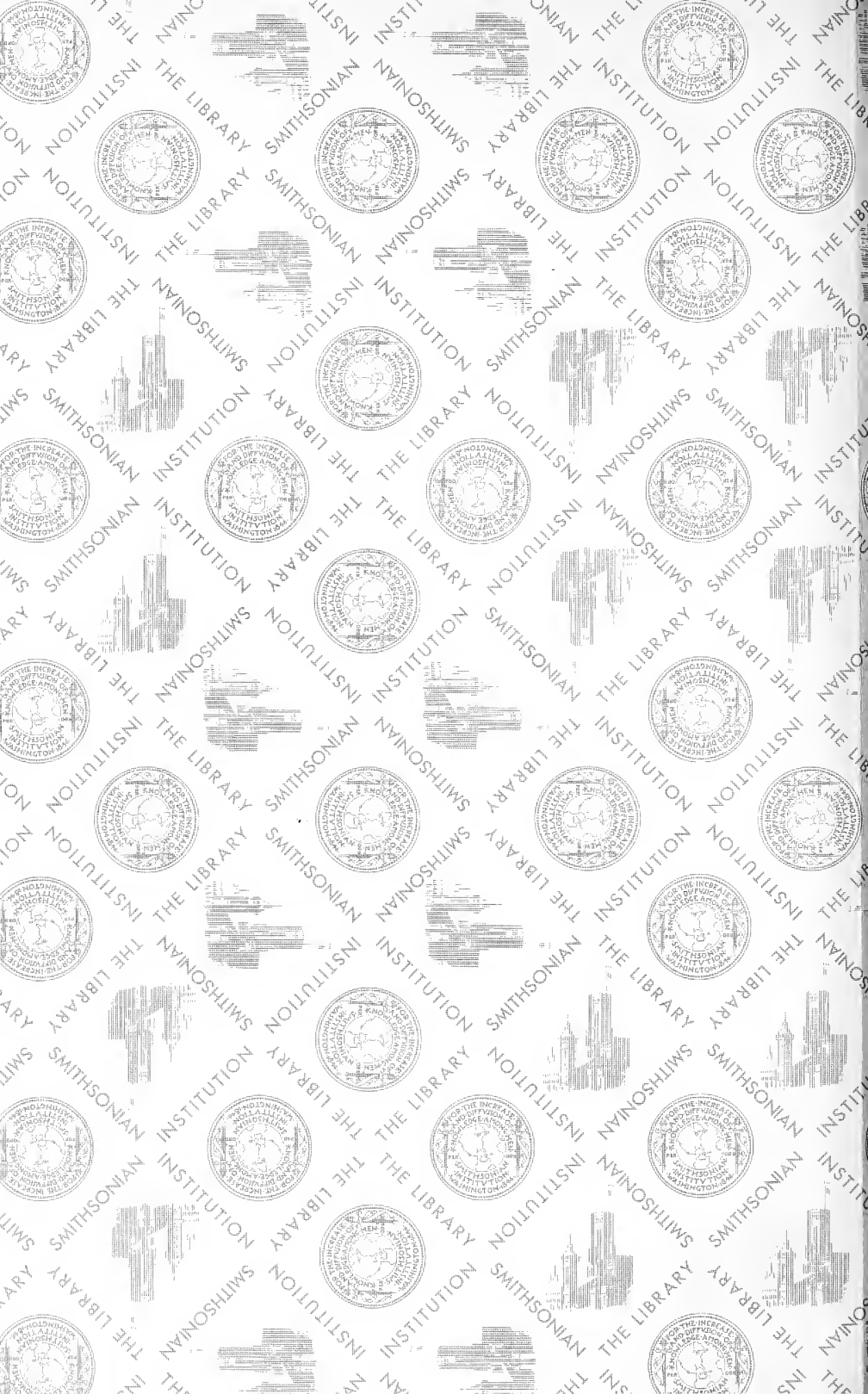
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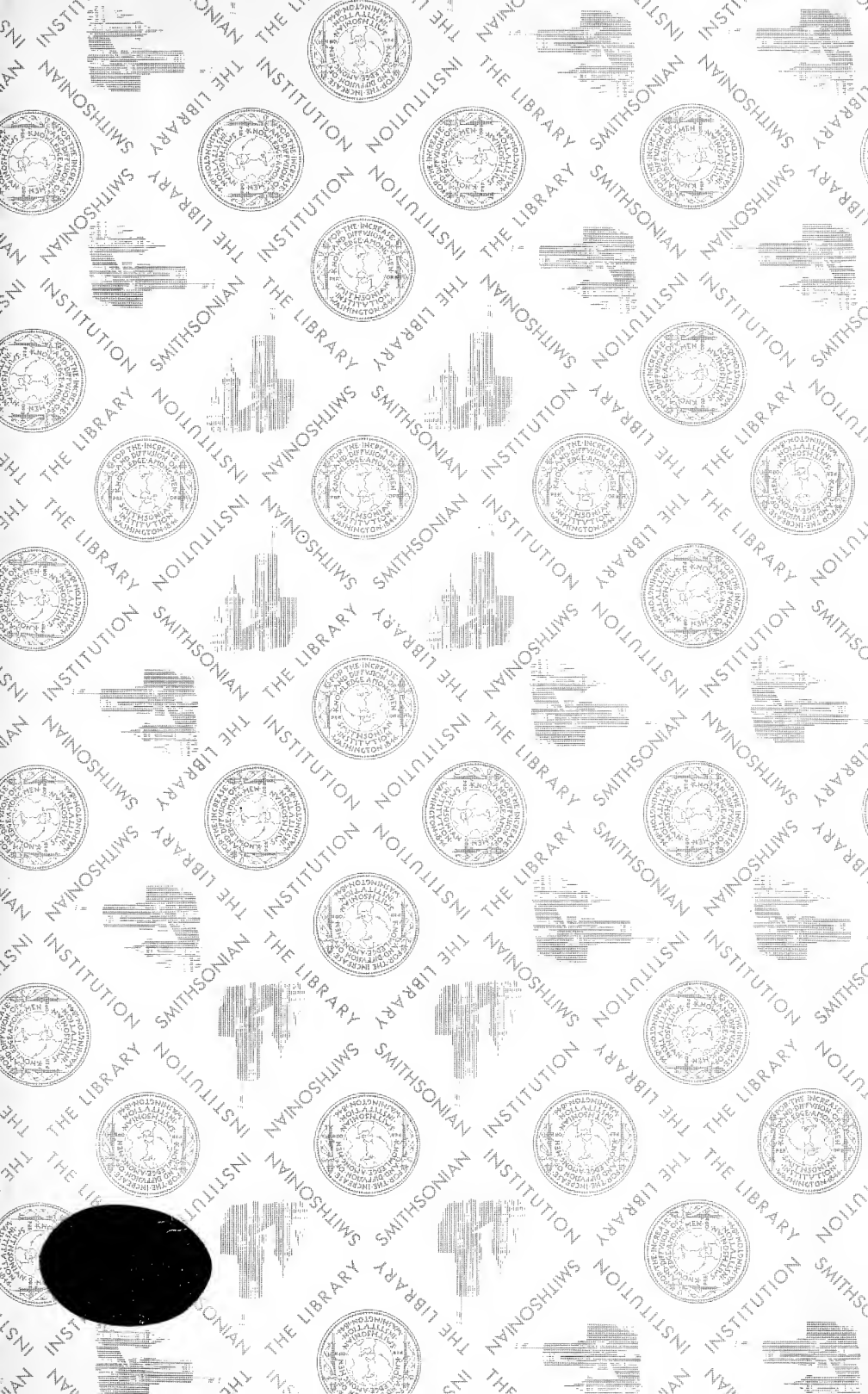
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